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ABSTRACT

This document contains 12 competency profiles for tech prep courses within the engineering technologies cluster. The document consists of the following sections: (1) systemic curriculum reform philosophy--Ohio's vision of tech prep and its six critical components; (2) an explanation of the process of developing the tech prep competencies; (3) a listing of the partners from business and industry who participated in the competency development process; (4) a list of the educational partners in the process; (5) a sample tech prep competency profile for a manufacturing technician program; (6) a short explanation of how to use the document; (7) a matrix and definitions for each of the 12 technical occupations within the engineering technologies cluster; (8) an essential competencies section that outlines the units that appear in each of the individual occupations as well as in various cluster combinations; and (9) 12 sets of competencies, each containing both core and specialized units for a specific occupation within the engineering technologies core. The competencies are supplied for the following occupations: electronics technician, electrical maintenance technician, instrumentation control technician, electromechanical technician, mechanical technician, industrial manufacturing technician, CADD (computer-assisted design and drafting) technician; tool and die technician, plastics technician, quality control technician, computer systems technician, and computer programming technician. Contains 50 references. (KC)

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Tech-Prep Competency Profiles

within the

Engineering Technologies Cluster

Electronics Technician
Electrical Maintenance Technician
Instrumentation Control Technician
Electromechanical Technician
Mechanical Technician
Industrial Manufacturing Technician
CADD Technician
Tool & Die Technician
Plastics Technician
Quality Control Technician
Computer Systems Technician
Computer Programming Technician

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Tech-Prep
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within the

Engineering
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Computer Systems Technician
Computer Programming Technician

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How to Use the TCP Binder

This binder is divided into the following sections:

Systemic Curriculum Reform Philosophy shares Ohio's vision of Tech Prep, theTech Prep Path, and six critical components which guide Tech Prep consortia.

The TCP Process explains the philosophy behind the development of Tech-Prep Competency Profiles (TCPs) and details the TCP process that yielded this composite binder on Engineering Technologies.

TCP Partners from Industry is a listing of the business, industry, and labor representatives who participated in the development of TCPs within the Engineering Technologies.

TCP Partners from Education is a listing of the secondary and postsecondary educators who participated in the development of TCPs within the Engineering Technologies.

Sample TCP—This section contains an actual sample TCP from the Clark State Tech Prep Consortium for a Manufacturing Technician Program.

How to Use the TCP Binder is the section you are reading. It is intended to serve as a locating device as you use the binder.

TCP Matrix—This section provides definitions for each of the twelve technical occupations within this Engineering Technologies Cluster and an actual matrix for your use in compiling Draft competency lists to develop a Tech-Prep Competency Profile that fits the labor market needs of your consortium.

Essential Competencies outlines the units that appear in each of the individual occupations as well as in various cluster combinations. These competencies may vary slightly due to program emphasis, yet they should be viewed as essential to Tech Prep success within the Engineering Technologies.

—continued on the reverse—

Each of the following sections of the binder contain both core and specialized units for a specific occupation within the Engineering Technologies. Remember the following as you use these twelve sections, along with the TCP Matrix:

> All the units listed in these sections will not necessarily apply to your situation, nor will all the competencies within each unit be appropriate. For example, some units that are listed will not appear in a Final TCP, others will, and still others will only appear in partial form. Likewise, some competencies and/or competency builders will either be (1) added, (2) deleted, or (3) altered in their wording in a Final TCP. In some cases the number of units listed far exceeds the amount of content that can be covered within a 4 + 2 TPAD Program.
>
> Also note that several units appear within each specific occupation and should only be listed once if you are compiling a cluster of occupations (e.g., Electronics Technician, CADD Technician, and Quality Control Technician as an Engineering Technologies Cluster). Always review each list of units against the TCP Matrix and your labor market demands before attempting verification (TCP Part I), leveling (TCP Part II), and teambuilding (TCP Part III).

Electronics Technician
Electrical Maintenance Technician
Instrumentation Control Technician
Electromechanical Technician
Mechanical Technician
Industrial Manufacturing Technician
CADD Technician
Tool & Die Technician
Plastics Technician
Quality Control Technician
Computer Systems Technician
Computer Programming Technician

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Systemic Curriculum Reform Philosophy

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OHIO'S VISION

Tech Prep in Ohio *is defined as a competency-based program of combined secondary and postsecondary education and occupational experience that includes a common core of required proficiency in mathematics, science, communication, and technologies designed to lead to an associate degree or two-year postsecondary certificate in specific career fields.* Our goal is to produce a highly educated and qualified workforce that is reponsive to the needs of business, industry, and labor.

Through Ohio's statewide network of consortia, Tech Prep promotes effective linkages among secondary and postsecondary schools and colleges. Each consortium is comprised of (a) at least one public community college, public technical college or branch campus offering technical education associate degree programs, (b) one or more vocational education planning districts (VEPDs), and (c) business, industry, and labor partners. Associate schools within each VEPD, co-located regional campuses, four-year universities, Job Training Partnership Act (JTPA) Service Delivery Areas (SDAs), and Ohio's Thomas Edison programs are encouraged to be active members of the consortium.

Starting with the student's Individual Career Plan (ICP) in grade 9, Tech Prep programs arrange the study of mathematics, science, communications, technology, and specific technical skills in a **step-by-step progression of coordinated curricula**. The goal of Ohio's Tech Prep program is to produce students who possess the advanced skills necessary to enter technical occupations by the end of a two-year postsecondary degree, school-to-work, or an apprenticeship program. This is to be achieved through an unduplicated program of study that is responsive to the changing technical needs of business, industry, and labor.

Tech Prep programs do not focus on linking what Ohio is currently doing at the secondary level with what is currently being offered at the postsecondary level, but rather **focus on achieving systemic change at both levels**. In order to achieve this ambitious outcome, Ohio's Tech Prep programs require academic, occupational, and employability competency attainment at both the secondary and postsecondary levels.

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OHIO'S VISION

AT THE SECONDARY LEVEL:

- **Academic competency** requirements must be defined at the end of grade 12 and obtained through college-prep courses or applied academic courses.
- **Occupational competency** requirements and employment options must be defined at the end of the 12th grade. Occupational competencies at the secondary level may be obtained through vocational education, technical education (using postsecondary options), school-to-work, or an apprenticeship program.
- **Employability competency** requirements must be defined at the end of grade 12.

AT THE POSTSECONDARY LEVEL:

- **Academic competency** requirements must be defined at the end of the postsecondary degree, school-to-work, or apprenticeship program.
- **Occupational competency** requirements must be defined by the end of the postsecondary degree, school-to-work, or an apprenticeship program. Occupational competencies at the postsecondary level may be obtained through technical education (using postsecondary options), school-to-work, or an apprenticeship program.
- **Employability competency** requirements must be defined at the end of the postsecondary degree, school-to-work program, or apprenticeship program.

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Tech Prep in Ohio is an educational path that prepares students for employment in a technical occupation. Tech Prep prepares students for careers requiring specific occupational course work in high school and a two-year college technical degree or two-year postsecondary certificate program. In addition, Tech Prep students have the option to go directly to work after high school or to a four-year college or university.

Ohio's Tech-Prep Path

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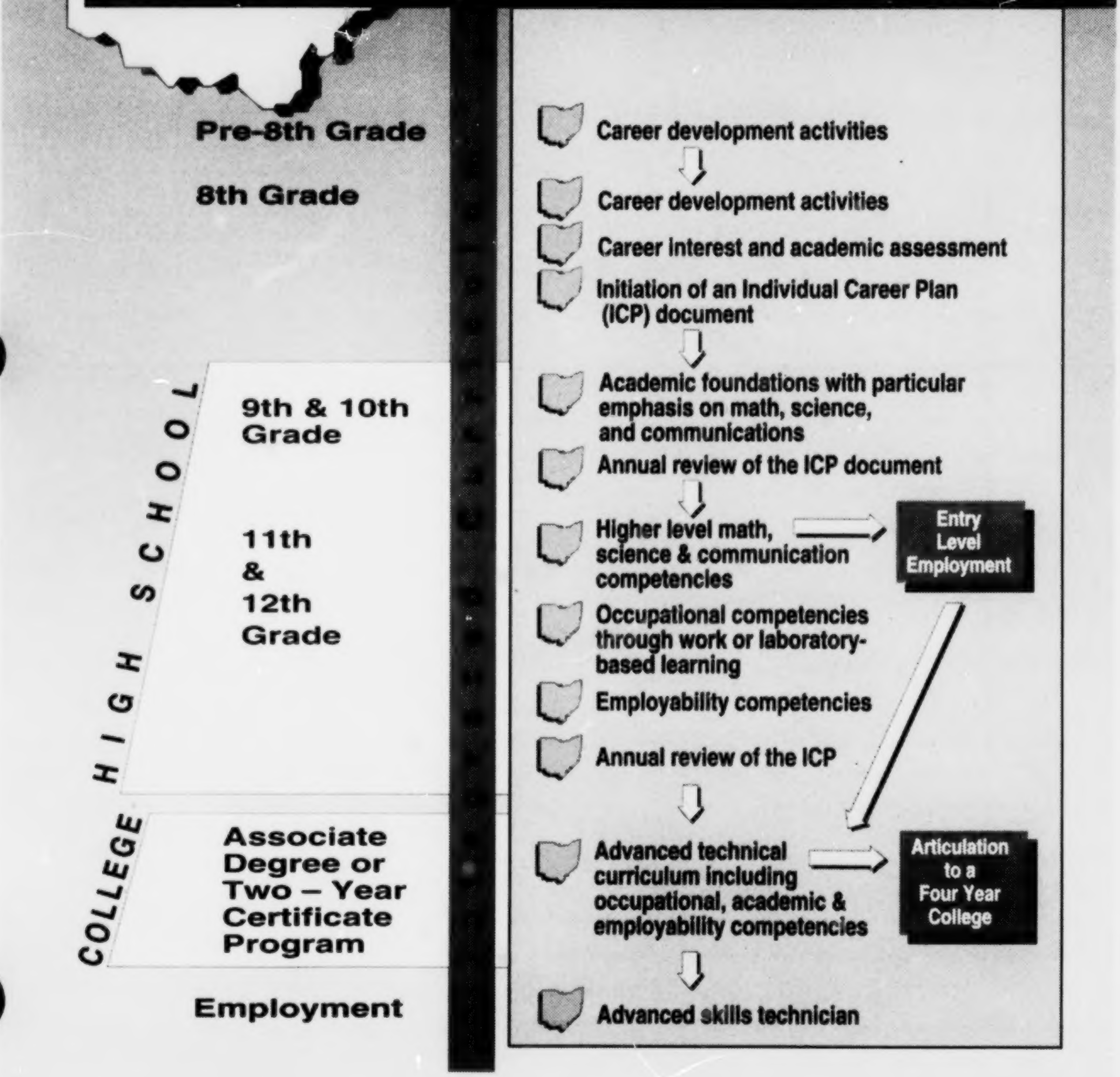
Tech-Prep in Ohio is an educational path that prepares you for employment in a high-skill technical occupation. Careers in Tech-Prep usally require specific vocational-technical course work in high school and two years of education beyond high school. However, if you enroll in a Tech-Prep program you might also be prepared to go directly to work after high school or to a four-year college or university.



Pre-8th Grade
- Career development activities

8th Grade
- Career development activities
- Career interest and academic assessment
- Initiation of an Individual Career Plan (ICP) document

HIGH SCHOOL

9th & 10th Grade
- Academic foundations with particular emphasis on math, science, and communications
- Annual review of the ICP document

11th & 12th Grade
- Higher level math, science & communication competencies → Entry Level Employment
- Occupational competencies through work or laboratory-based learning
- Employability competencies
- Annual review of the ICP

COLLEGE

Associate Degree or Two – Year Certificate Program
- Advanced technical curriculum including occupational, academic & employability competencies → Articulation to a Four Year College

Employment
- Advanced skills technician

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OHIO'S CRITICAL COMPONENTS

I. SYSTEMIC CHANGE

Tech Prep programs will demonstrate systemic change. New, creative, and innovative options will be provided to students. These options will not focus on linking what Ohio is currently doing at the secondary level with what is currently being offered at the postsecondary level, but rather focus on achieving systemic change at both levels.

II. EXPANDED STUDENT OPPORTUNITY

Tech Prep programs will provide expanded opportunities for all students.

III. PARTNERSHIPS

Tech Prep programs are a partnership between secondary education, postsecondary education, and business, industry, and labor.

IV. EARLY INDIVIDUAL CAREER EDUCATION

Early career education and career exploration are essential to Tech Prep programs. Starting with the student's Individual Career Plan (ICP) in grade 9, Tech Prep programs arrange the study of mathematics, science, communication, technology, and specific technical skills in a step-by-step progression of coordinated curricula.

V. COMPETENCIES

Academic, occupational, and employability competencies are required at both the secondary and postsecondary levels, enabling a student to enter employment at both the completion of the 12th grade and the end of the postsecondary program.

VI. ADVANCED SKILLS

Tech Prep curriculum must prepare students with the advanced skills necessary for technical occupations by the end of a two-year postsecondary degree, school-to-work, or an apprenticeship program through an unduplicated program of study that is responsive to the changing technical needs of business, industry, and labor.

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The TCP Process

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The Philosophy Behind Tech-Prep Competency Profiles (TCPs)

Federal Guidelines

As the 21st century approaches our need to achieve systemic educational change is paramount. In direct response to Goal 5 of the National Education Goals, Section 347 of PL. 101-392 states: the term "tech-prep education program" means a combined secondary and postsecondary program which (1) leads to an associate degree or 2-year certificate; (2) provides technical preparation in at least one field of engineering technology, applied science, mechanical, industrial, or practical art or trade, or agriculture, health, or business; (3) builds student competence in mathematics, science, and communications (including through applied academics) through a sequential course of study; and (4) leads to placement in employment. Tech Prep is an effective way for educators to join forces with business, industry, and labor to offer expanded opportunities to the future work force. Yet it must be more than just articulation agreements, applied academics or advanced standing programs.

Systemic Curriculum Reform

In Ohio, Tech Prep is a reconceptualization of curriculum designed to train a more flexible, knowledgeable, and technically adept workforce. We are (1) setting standards that will equip students with the knowledge and skills needed for employment and the lifelong learning skills needed to retrain as job market requirements change; (2) improving the match between what work requires and what students are taught; (3) addressing the curricular needs of differences among students; and (4) providing continuity in learning by teaching in context. Yet, the primary obstacle of systemic curriculum reform is individuals who fear change.

The TCP Process

Therefore, Ohio is using a process which allows individuals from both secondary and postsecondary education and business, industry, and labor to deal with change in a positive manner by being active decision makers in the development of Tech Prep curriculum. The Tech-Prep Competency Profile Process produces a list of occupational, academic, and employability competencies that need to be obtained during grades 9-12 and the first two years of postsecondary training—leading to an associate degree or two-year postsecondary certificate—in preparation for technician level positions in business, industry, and labor. Each step of the process is described on the following pages.

Prior to Part I of the TCP Process...

—Labor market survey data is collected and analyzed to determine the need for "technicians" within the consortium.

—Once that individual occupation or cluster of occupations has been identified, definitions are prepared and approved by the governing body of the consortium. [See "TCP Matrix" for definitions.]

—Those definitions are then used to identify the units needed to compile a draft list of competencies for use in Part I of the TCP Process.

NOTE: The Original Draft TCP was derived from an international literature review that examined items that were (1) not listed in the bibliographies of Ohio's Competency Analysis Profiles (national literature review was completed in 1990); (2) postsecondary academic and technical course outlines and DACUM charts; and (3) items that had been entered into ERIC between 1990 and 1993-94. Then, as Engineering Technologies TCPs were conducted across Ohio during 1993 and 1994, each consortium's resulting TCP was folded into the Original Draft TCP. This created a set of core units with a very high rate of appearance on most TCPs and another set of units that only appear on certain TCPs due to specific labor market demands (e.g., chemical industries along the Ohio River). This compiling mechanism enabled Ohio to prepare the contents of this binder. **[See "TCP Matrix" for a listing of all the units, both core and specialized.]** The resulting partial bibliography from the compiled TCPs follows.

—Partial Engineering Technologies Bibliography—

Every item used to develop specific TCPs (e.g., individual college course outlines) is not included.

Career merit achievement plan (career MAP). Computer engineering technology. (1991). Tallahassee, FL: Florida Department of Education, Division of Vocational, Adult and Community Education.

Competency profile. Drafting. (July 1990). Columbia, MO: University of Missouri-Columbia, College of Education, Department of Practical Arts and Vocational-Technical Education, Instructional Materials Lab.

Competency profile. Electrical trades. (May 1989). Columbia, MO: University of Missouri-Columbia, College of Education, Department of Practical Arts and Vocational-Technical Education, Instructional Materials Lab.

—Partial Engineering Technologies Bibliography—

Every item used to develop specific TCPs (e.g., individual college course outlines) is not included.

Competency profile. Electronics. (June 1986). Columbia, MO: University of Missouri-Columbia, College of Education, Department of Practical Arts and Vocational-Technical Education, Instructional Materials Lab.

Competency profile of plastics engineering technician. (July 1992). Columbus, OH: The Ohio State University, Center on Education and Training for Employment.

Curricula 2000. Workshop proceedings. Ideal models in manufacturing education. (February 1990). Dearborn, MI: Society of Manufacturing Engineers.

Electrical/instrumentation control technologies tech prep competency profile . (1993). Marietta, OH: Washington-Morgan Counties Tech Prep Consortium.

Electrical maintenance technician tech prep competency profile (1993). Mansfield, OH: North Central Tech Prep Consortium.

Electronics technician tech prep competency profile (1993). Mansfield, OH: North Central Tech Prep Consortium.

Electronics technician tech prep competency profile (1993). Piqua, OH: Upper Miami Valley Tech Prep Consortium.

Electronics technician tech prep competency profile (1994). Lima, OH: West Central Ohio Tech Prep Consortium.

Engineering technologies. Syllabi. (1992). Newark, OH: Central Ohio Technical College, Engineering Technologies.

Engineering technologies tech prep competency profile . (1993). Akron, OH: Akron Tech Prep Consortium.

Engineering technologies tech prep competency profile . (1994). Steubenville, OH: Jefferson County Tech Prep Consortium.

Engineering technologies tech prep competency profile . (1994). Zanesville, OH: Mid-East Ohio Tech Prep Consortium.

Engineering technologies tech prep competency profile . (1994). Marion, OH: Partners of Marion Tech Prep Consortium.

Engineering technologies tech prep competency profile . (1993). Canton, OH: Stark County Tech Prep Consortium.

Engineering technologies tech prep competency profile (1993). Portsmouth, OH: Ohio South Tech Prep Consortium.

Florida vocational program for manufacturing technology (May 1985). Tallahassee, FL: Florida Department of Education, Division of Vocational, Adult and Community Education.

Florida vocational program guide for laser electro-optic technology. (June 1991). Tampa, FL: University of South Florida—Tampa, College of Education, Department of Adult and Vocational Education.

Florida vocational program guide for micro-computer electronics. (June 1988). Tampa, FL: University of South Florida—Tampa, College of Education, Department of Adult and Vocational Education.

—Partial Engineering Technologies Bibliography—

Every item used to develop specific TCPs (e.g., individual college course outlines) is not included.

Graded course of study for polymer science and testing. (March 1988). Stow, OH: Stow City School District.

Industrial manufacturing tech prep competency profile. (1994). Fremont, OH: Workforce Development Council.

Integrated manufacturing tech prep competency profile . (1993). Salem, OH: Columbiana County Tech Prep Consortium.

Machine tool and die moldmaker tech prep competency profile . (1994). Zanesville, OH: Mid-East Ohio Tech Prep Consortium.

Manufacturing systems. Curriculum guide for technology education. (1988). Frankfort, KY: Kentucky Department of Education, Office of Vocational Education.

Manufacturing technician tech prep competency profile (1994). Lima, OH: West Central Ohio Tech Prep Consortium.

Manufacturing technician tech prep competency profile (1993). Mansfield, OH: The North Central Tech Prep Consortium.

Manufacturing technician tech prep competency profile (1993). Piqua, OH: Upper Miami Valley Tech Prep Consortium.

Manufacturing technician tech prep competency profile (1994). Springfield, OH: Clark State Tech Prep Consortium.

Manufacturing technology. Draft copy. (1983). Memphis, TN: Tennessee Department of Education, Division of Vocational-Technical Education, Development Project.

Materials science and technology. A preview of an exemplary high school course where students explore new frontiers of scientific and vocational education know-how. (August 1990). Richland, WA: Battelle Pacific Northwest Laboratories; Ellensburg: Central Washington University; Portland, OR: Northwest Regional Educational Laboratory; and Richland, WA: Richland School District 400.

Model competency-based language arts program. (1992). Columbus, OH: Ohio Department of Education, Division of Curriculum, Instruction, and Professional Development.

Model competency-based mathematics program. (1991). Columbus, OH: Ohio Department of Education, Division of Elementary and Secondary Education.

Model competency-based science program. Draft copy. (1994). Columbus, OH: Ohio Department of Education, Division of Professional Development.

Occupational competencies. A study of the vocational-technical education needs of the manufacturing and aviation maintenance industries. (July 1991). Washington, DC: The National Council on Vocational Education.

—Partial Engineering Technologies Bibliography—

Every item used to develop specific TCPs (e.g., individual college course outlines) is not included.

Ohio competency analysis profile. Drafting. (April 1992). Columbus, OH: Ohio Department of Education, Division of Vocational and Career Education, and The Ohio State University, Center on Education and Training for Employment, Vocational Instructional Materials Laboratory

Ohio competency analysis profile. Electronics. (March 1992). Columbus, OH: Ohio Department of Education, Division of Vocational and Career Education, and The Ohio State University, Center on Education and Training for Employment, Vocational Instructional Materials Laboratory.

Ohio competency analysis profile. Industrial maintenance. (August 1991). Columbus, OH: Ohio Department of Education, Division of Vocational and Career Education, and The Ohio State University, Center on Education and Training for Employment, Vocational Instructional Materials Laboratory.

Ohio competency analysis profile. Machine trades. (1992). Columbus, OH: Ohio Department of Education, Division of Vocational and Career Education, and The Ohio State University, Center on Education and Training for Employment, Vocational Instructional Materials Laboratory.

Ohio competency analysis profile. Welding. (August 1991). Columbus, OH: Ohio Department of Education, Division of Vocational and Career Education, and The Ohio State University, Center on Education and Training for Employment, Vocational Instructional Materials Laboratory.

Polymer technology. (December 1991). Akron, OH: The University of Akron, Community and Technical College, Engineering and Science Technology Division.

Quality assurance program development. Curriculum development. (1991). Madison, WI: Wisconsin State Board of Vocational, Technical, and Adult Education.

Ronake area 2 + 2 program in automated manufacturing technology. (November 15, 1990). Richmond, VA: Virginia State Department of Education, Division of Vocational and Adult Education.

Snyder, B. (1990). *Industrial electronics II for ICT. Instructor's guide.* Austin, TX: University of Texas at Austin, Division of Continuing Education, Extension Instruction and Materials Center.

Task analysis for electronics technology. (1991). Richmond, VA: Commonwealth of Virginia, Department of Education, Vocational and Adult Education.

Tech Prep occupational analysis. Electronics. (November 1992). Cleveland, OH: The North Coast Tech Prep Consortium.

Technical committee report for applied welding technology. (1990). Boise, ID: Idaho State Board for Vocational Education.

Technical committee report for drafting and design technology. (1990). Boise, ID: Idaho State Board for Vocational Education.

—Partial Engineering Technologies Bibliography—

Every item used to develop specific TCPs (e.g., individual college course outlines) is not included.

Technical committee report for electronic technology. (1992). Boise, ID: Idaho State Board for Vocational Education.

Technical committee report for industrial maintenance technology. (1990). Boise, ID: Idaho State Board for Vocational Education.

Technical committee report for precision machining technology. (1990). Boise, ID: Idaho State Board for Vocational Education.

Tool and die technician tech prep competency profile (1993). Mansfield, OH: North Central Tech Prep Consortium.

Part I of the TCP Process...

Business, industry, and labor representatives from a Tech Prep consortium's labor market area are convened (8-14 hours) to identify the occupational, academic, and employability competenices needed by one or more technician-level positions.

—First, a brainstorming session is conducted to identify the critical skills needed by the technician(s) positions being targeted (e.g., Electronics Technician, or a cluster of occupations within Engineering Technologies).

—Second, a Draft competency list that has been compiled in accordance with definitions of the individual or group of technician-level position(s) identified as the Tech-Prep consortium's labor market need is offered for consideration. Then, business, industry, and labor representatives eagerly (1) add to, (2) delete from, and (3) alter the wording of the Draft competency list until it reflects the needs in the consortium's labor market area. It is critical that business, industry, and labor representatives alter the Draft to fit the needs of their area, because it will be the catalyst for systemic curriculum reform in their schools and colleges—ultimately altering the type of employee pool available.

—Third, representatives are provided with copies of Ohio's Language Arts (Communications), Mathematics, and Science Models. They are asked to circle the code beside each competency they think is appropriate to be taught in the context of Engineering Technologies. This is done by silent, written votes so that educational levels of the committee members will not sway the results. After tabulating the responses, the corresponding competencies are identified with an asterisk (*). **[Refer to Part II of the TCP Process for further information.]**

Part II of the TCP Process...

Both the academic and vocational-technical faculty members who will be delivering the competencies in the consortium's participating secondary and postsecondary schools meet (6 hours) to assign grade levels of mastery to each competency on the list.

—Codes are used to indicate two-year increments (10, 12, AD) during which the competencies will be introduced (I), reinforced (R), mastered (M), taught on an ongoing (O) basis, or on-the-job training (OJT). Competencies may carry multiple codes such as I-10, M-12, R-AD, and O. Faculty members are also asked to identify any obstacles they see in delivering the competencies as stated (e.g., wording, equipment, inservice needs). These issues are recorded and addressed during Part III of the TCP Process.

—Faculty members are given the list of academic competencies that business, industry, and labor representatives identified (during Part I) as appropriate to be taught in the context of Engineering Technologies (indicated by an asterisk*) and asked to verify the validity of those choices [Refer to Part III of the TCP Process], as well as indicate (using #) other competencies that need to be taught as an integral or supporting part of those *competencies. In this way, faculty begin discussing ways to apply academic content to the area of Engineering Technologies and ways to collaborate across disciplines to accomplish that task. Following is a mathematics sample faculty would examine during Part II.

Unit: Mathematics Literacy (Ohio's Mathematics Model 9-12) *** = Industry identified these to be taught using applied methods** **# = Teachers identified these to also be taught using applied methods** **Note: The remaining competencies are to be taught using regular or applied methods.**	**10**	**12**	**AD**	**O**	**OJT**
Subunit: Data Analysis and Probability					
Describe normal curve in general terms and use its properties*					
Create and interpret discrete probability distributions #					
Understand concept of random variable					

Part III of the TCP Process...

Both groups, from Parts I and II, meet together (4 hours) to address perceived obstacles on the competency list and discuss how they, as a Tech Prep team, can best work together to facilitate the delivery of the Tech Prep curriculum by addressing or removing each of the obstacles identified in Part II. This is the "magic" of the TCP Process—with all the individuals at the same table the discussion of true systemic change can take place, especially if the focus of that discussion is improving the education and training of students who will be future technicians.

—TCPs are then used by Tech Prep consortia as the foundation for developing their systemic reform curriculum pathway(s). An important step in developing curriculum pathways from TCPs is the completion of the leveling process, down through all the competency builders.

Sample Section of a Completed TCP Accountabilty Chart

Unit: Computer Literacy	**10**	**12**	**AD**	**O**	**OJT**
Competency: Explain information processing cycle	**I**	**M**			
Competency Builders: Define operating systems (e.g., DOS, OS/2, UNIX)	M	R			
Differentiate between data files and program files	I	M			
Explain PC layout	I	M			
Explain PC network layout		M			
Differentiate hardware from software	M	R			
Differentiate open from proprietary archietecture		M			
Competency: Operate computer hardware	**I**	**R**	**M**	√	√
Competency Builders: Practice proper media handling techniques (e.g., magnetic fields, dust, liquids)	I	M	R	√	√
Identify hardware and its use	I	M	R	√	√
Use hardware (e.g., mouse, drives, modems, cables, printers, digitizers, scanners, protection devices)	I	R	M	√	√
Keyboard efficiently		M	R	√	√
Demonstrate basic care of hardware	I	M	R	√	√
Explain need for an application of security levels		R	M	√	√
Apply basic hardware troubleshooting skills			M	√	√
Explain hardware addressing techniques		I	M	√	√

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TCP Partners from Industry

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Plastipak Packaging, Incorporated, Medina

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Manufacturing Technician TCP

Stewart Albert, Welder Repairman
Navistar International Transportation Corporation, Springfield

Jeff Amlin, Assistant CAD Administrator
The William Bayley Company, Springfield

Don Boysel, Jr., Programming Manager
Carmichael Machine Corporation, New Carlisle

Robert Griffith, CNC Programming/Industrial Engineer
Cascade Corporation, Springfield

Greg Howard, Quality Control Manager
Pentaflex, Incorporated, Springfield

Reijo Kamula, Technical Training Manager
Kone Cranes, Springfield

Doug Kirkpatrick, Plant Maintenance
Holophane Company, Incorporated, Springfield

Duke Knepper, Maintenance Group Leader/Technician
Rittal Corporation, Springfield

James Kotterman, Electrical Planning Engineer
Navistar International Transportation Corporation, Springfield

James McDermott, Maintenance Technician
Cascade Corporation, Springfield

Ralph Risner, CAD/CAM Technician
Rittal Corporation, Springfield

Wally Sothard, Plant Maintenance Manager
ITT Jabsco, Springfield

Clark Stewart, Production Quality Manager
Teikuro Corporation, Springfield

George Tomashot, Tool Engineering
Holophane Company, Incorporated, Springfield

Robert VanKuiken, General Foreman/Processing Engineer
Navistar International Transportation Corporation, Springfield

Clark State Tech Prep Consortium
Business/Industry/Labor Representatives (continued)
Manufacturing Technician TCP

Jeff Van Zant, Quality/Machine Center
Houston Machine, Incorporated, Springfield

Mike Williams, Programming Manager
Eagle Tool & Machine Company, Incorporated, Springfield

Bill Woodruff, Maintenance Electrician
Navistar International Transportation Corporation, Springfield

Columbiana County Tech Prep Consortium
Business/Industry/Labor Representatives
Integrated Manufacturing Technology TCP

Chet Berry, CAD Supervisor
Aerotech, Salem

Jeff Betler, Process Engineer
PCC Airfoils, Incorporated, Minerva

Dale Brittan, Senior Application Engineer
Legendary Technology, Incorporated, Stow

Lee Brown, Supervisor, Plant Electrical/Electronic Systems
American Standard, Salem

David Cline, Process Engineer
BOC Stamping (GM), North Benton

Brad Cranmer, Tool & Die Maker
Sekely Industries, Salem

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Solartec, Incorporated, Salem

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Schneider Engineers, East Liverpool

Steve Floor, Designer
RAG Tooling, Salem

Susan Golding, Designer
Pump Hydraulics, Crane Deming Pump, Salem

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Mitchell Hawkins, Estimating/Sales
Barclay Machine, Salem

John Kysfern, Owner
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Vertex Development Corporation, Girard

Columbiana County Tech Prep Consortium
Business/Industry/Labor Representatives (continued)
Integrated Manufacturing Technology TCP

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North Start Industries, Salem

Ernest Sigle, President
Jefco Industries, Columbiana

Ted Yuhaniak, Designer/CAD Operator
Lincoln Machine Company, Salem

Jefferson County Tech Prep Consortium
Business/Industry/Labor Representatives
Engineering Technology Cluster TCP

Frank Argentine, Service & Maintenance Electrician
Wheeling—Pittsburgh Steel, Steubenville

Bob Bailey, Quality Assurance
Hancock Manufacturing Company, Toronto

Barry Fluxe, Training Supervisor
Ohio Edison—Sammis Plant, Stratton

John Grimm, Tool & Dye Maker
Weirtech, Weirton

Robert Moreley, Machine Trades Instructor
Weirton Steel Corporation, Weirton

Gene Schirra, Superintendent, Labor Relations
Wheeling—Pittsburgh Steel, Steubenville

Len Smith, Chief Engineer
WTOV-TV9, Steubenville

Brady Thomas, Electrician
U.S. Can Company, Weirton

Mid-East Ohio Tech Prep Consortium
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Engineering Cluster TCP

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Anchor Glass Container, Zanesville

Gerald DesRosiers, Technician
Cambridge Tool & Die

Paul Dutro, Former Machinist
Mid-East Ohio District, Zanesville

Mel Hazzard, Project Engineer
Coshocton Stainless Division—Armco Corporation

Jamie Miller, Project Engineer
ETS Incorporated

Rick Miller, Project Engineer
Limbach Company

Scott Rambo, Engineering Technician
Anchor Glass Container

Tom Seagro, Works Manager
Triple Arrow Plastics

Mike West, Consultant
Natural Fuel Management Group

Sam Wilson, Former Plant Manager
Anchor Glass Container

Mid-East Ohio Tech Prep Consortium
Business/Industry/Labor Representatives
Machine Tool, Die & Moldmaking TCP

Steve Blackford, Programming Engineer
Cambridge Tool & Die, Cambridge

Charles Brinkman, Consultant
Wright Quality Corporation, Cleveland

Steve Brock, Plant Manager
Anchor Glass Container

Noel Brumage, Tool Engineer
United Technologies, Zanesville

Phil Davis, Supervisor
Owens Corning Fiberglass, Newark

Ron Edwards, President, Machinist Union
Owens Corning Fiberglass, Newark

Michael C. Emmert, Machinist
Anchor Glass Container, Zanesville

Michael J. Emmert, Machinist
Anchor Glass Container, Zanesville

North Central Tech Prep Consortium
Business/Industry/Labor Representatives
Electrical Maintenance TCP

Larry Backensto, Electrician
Gorman-Rupp, Mansfield

Brian Clinger, Die Maker
General Motors Corporation, Mansfield

James Gray, Sr., Engineer/Operations Support
Sprint United Telephone Systems, Mansfield

Mike Hamilton, Maintenance Electrician
Copperweld, Shelby

Jim Henson, Training Coordinator
General Motors Corporation, Mansfield

Emmett Love, Engineering
Neer Manufacturing, Mansfield

Jerry Lowe, Engineer
National Latex, Ashland

Joe McGlone, Supervisor Electronics
Empire Detroit, Mansfield

Jim Sauber, Maintenance
National Latex, Ashland

John Simmermon, Residential Marketing Supervisor
Ohio Edison, Mansfield

Kevin Smith, Maintenance Electrician
Midwest Industries Division, Willard

North Central Tech-Prep Consortium
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Electronics Technician TCP

Helen Balcom, Consultant
Self-Employed, Lexington

Les Bowers, Staff Administrator
Sprint United Telephone Systems, Mansfield

Bob Muth, Electrical Technician
Empire Detroit, Mansfield

Kevin Smith, Maintenance Electrician
Midwest Industries Division, MTD, Willard

Jim Wise, Maintenance Planner/Analysis
Copperweld, Shelby Division, Shelby

North Central Tech Prep Consortium
Business/Industry/Labor Representatives
Electronics Technician TCP

Tom Ruggles, Electronic Engineering Technology Instructor
North Central Technical College, Mansfield

Joe Sminchak, Electronic Engineering Technology Instructor
North Central Technical College, Mansfield

Randy Storms, Electronics Instructor
North Central Technical College, Mansfield

John Toney, Dean, Engineering Technology Division
North Central Technical College, Mansfield

Joe Wagner, Electronics Engineering Technology Instructor
North Central Technical College, Mansfield

Tammy Williamson, Mathematics Instructor
Madison High School, Mansfield

North Central Tech Prep Consortium Business/Industry/Labor Representatives Manufacturing Technician TCP

Gary Arnold, TQM Coordinator
R.R. Donnelley & Sons Company, Willard

Kevin Brown, Assistant Superintendent
Fabrication, Therm-O-Disc Incorporated, Mansfield

Ron Deardorff
I.E. Hi-Stat, Mansfield

Twila Lucas, Press Room Facilitator
R.R. Donnelley and Sons Company, Willard

Allen Sanford
Mansfield Brass & Aluminum Corporation, New Washington

North Central Tech Prep Consortium
Business/Industry/Labor Representatives
Tool and Die Technician TCP

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Westinghouse, Mansfield

Bob Grover
Consultant, Lucas

Jake Kent, Foreman Machine Shop
Empire Detroit, Mansfield

Mark Koren, Fabrication Maintenance Engineer
Therm-O-Disc Incorporated, Mansfield

William Ludban
Lake Park Industry of Ohio, Greenwich

Eugene Pleiman
Self-Employed, Mansfield

Regis Pollack, Pattern Maker
General Motors Corporation, Mansfield

Ohio South Tech Prep Consortium
Business/Industry/Labor Representatives
Engineering Technology Cluster TCP

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Ohio Power, Portsmouth

Larry Bernhardt, Central Office Supervisor
GTE, Portsmouth

Debbie Clay, Supervisor Medical Technologist
VAMC, Chillicothe

Steve Collins, Financial Secretary
Plumbers & Steam Fitters Local 577, Portsmouth

Doug Farmer, Quality Control Specialist
New Boston Coke Corporation, New Boston

Richard Flanery, Manager Administration and Production Planning
Aristech Chemical Corporation, Ironton

Sandy Fout, Deputy Division Manager of Technical Operations
Martin Marietta Energy Systems, Incorporated, Piketon

Ralph Haas, Operations Technician
Columbia Gas Company, Portsmouth

Clarence Jackson, CIM Coordinator
Arrow Molded Plastics, Byesville

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International Brotherhood of Electrical Workers Local 575, Portsmouth

David Lewis, Research Engineer
BMI, South Webster

Tenny Martin, Human Resources Manager
Mills Pride, Waverly

Tim McGhee, Information Services Manager
Mills Pride, Waverly

Gerald R. Piatt, Business Agent
Millwright Local Union, South Point

Phil Pyle, Network Facility Engineer
GTE, Portsmouth

Ohio South Tech Prep Consortium
Business/Industry/Labor Representatives (continued)
Engineering Technology Cluster TCP

Norm Raybould, Personnel Administrator
RHF Enterprises, Chillicothe

Bill Rogers, Instrument Coordinator
Ashland Oil Refinery, Ashland

Richard Spaulding, Training Coordinator
Airstech Chemical Corporation, Ironton

Wayne Spetnagel, Department Superintendent
Martin Marietta Energy Systems, Piketon

Frank Tate, Superintendent of Quality Control
Aristech Chemical Corporation, Ironton

David Taylor, Personnel Administrator
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Engineering Technology Cluster TCP

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Ken Belk, Electric Designer
Fairfield Engineering, Marion

Dennis Brooks, Operations Supervisor
General Telephone Company, Marion

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Fairfield Engineering, Marion

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PT/MTC, Marion

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Stark County Tech Prep Consortium
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Engineering Technologies Cluster TCP

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Republic Engineered Steels, Massillon

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The Timken Company, Canton

John Glutting, Staff Engineer
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Interbold, Canton

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Republic Engineered Steels, Canton

Upper Miami Valley Tech Prep Consortium
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Hobart Brothers Company, Troy

Ron Good, Technical Analyst
American Matsushita Electronics Corporation, Troy

Julie Hall, Total Quality Facilitator
Allied Signal, Greenville

Steve Pfister, Plant Supervisor
Hartzell Propeller Incorporated, Piqua

Sam Puckett, Test Development Technician
Schindler Elevator, Sidney

Brent Rankin, Engineering Coordinator for Equipment and Service
Honda of America, Manufacturing Incorporated, Anna

Augie Roestamadcjhi, Engineer
Allied Signal, Greenville

Asha Saini, Process Controller
American Matsushita Electronics Corporation, Troy

Dennis Seger, Product Engineer
Cadillac Gage—Textron, Greenville

Upper Miami Valley Tech Prep Consortium
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Reinhard Honzak, Plant Manager,
SEW-Eurodrive Incorporated, Troy

Bill Kizer, Engineer
KTH Parts Industries, Incorporated, St. Paris

Mickey Langston, Senior Drafter
The B.F. Goodrich Company—B. F. Goodrich Aerospace, Troy

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Hartzell Propeller Incorporated, Piqua

Dan Morrow, Manufacturing Engineer
Cadillac Gage—Textron, Greenville

Don Nash, Associate
Honda of America Manufacturing Incorporated, Anna

Kevin Orndorff, CNC Programmer,
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Paul Pearson, Metal Treater
Hartzell Propeller Incorporated, Piqua

Mike Rowe, CNC Programmer
Lostcreek Tool & Machine Incorporated, Piqua

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Washington-Morgan-Meigs Tech Prep Consortium
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Electronics/Instrumentation Cluster TCP

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Shell Chemical Company, Belpre

Tom Eddy, Instrumentation Electrical Engineer
Chevron Chemical Company, Marietta

George Hendershot, President,
Hendershot Communications, Fleming

Allen Phelps, Head of Shipping
ARC Resin, Parkersburg

Larry Work, Electrical Technician
Elkem Metals, Marietta

West Central Tech Prep Consortium
Business/Industry/Labor Representatives
Manufacturing Engineering Technician TCP

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J.B. Tool & Machine, Incorporated, Wapakoneta

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Airfoil Textron, Lima

Mark Haushalter, Engineering Manager
Robinson Fin, Kenton

Thomas Iszory, Process Engineer
Teleflex, Van Wert

Steve Jordan, Mechanical Manager
Kennedy Manufacturing, Van Wert

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Metokote, Lima

Jim Miller, Owner
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Rod Miller, Processing Engineering Technician
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Terry Pinkerton, Process Engineer
Ford Motor Company, Lima

Bob Prater, CADD Technician
Omni Manufacturing, St. Marys

Brian Smith, Training Manager
Procter & Gamble, Lima

Paul Schneider, Manufacturing Engineer
Dana Corporation, Lima

West Central Tech Prep Consortium
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Manufacturing Engineering Technician TCP

Steve Uncapher, Process Engineering Technician
Aeroquip, Van Wert

Jim Young, Engineering Technician
B.P. Chemical, Lima

West Central Tech Prep Consortium
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Electronic Engineering Technician TCP

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Ford Motor Company, Lima

Chuck Biedelschies, Electronics Technician
Procter & Gamble, Lima

Dan Cassidy, Senior Equipment Engineer
Philips Display Components, Ottawa

Dave Fessler, Electronic Technician
Sundstrand Corporation, Lima

Chuck Hoersten, Electronic Control Systems Technician
Smith-Boughan, Lima

Jim Michael, Plant Manager
Neuman Industries, Delphos

Daniel Pierce, Superintendent of Maintenance
Definace College, Definace

Tom Ream, Manufacturing Technician
Triplett Corporation, Bluffton

Kevin Robertson, Electronics Technician
Sundstrand Corporation, Lima

Ben Sloan, Electronic Controls Technician
Airfoil Textron, Lima

Dale Snider, Electronic Engineering Technician
Teleflex, Van Wert

Dave Stickney, LAN Information Systems Technician
Sprint United Telephone, Bellefontaine

Mike Thitoff, Electronics Engineer
Dana Corporation, Lima

Fred Toitch, Electronics Technician
B.P. Chemical, Lima

Phil Vance, Electronics Technician
Metokote, Lima

West Central Tech Prep Consortium
Business/Industry/Labor Representatives (continued)
Electronic Engineering Technician TCP

Fred Vobbe, Chief Engineer
WLIO Television, Lima

John Walters, Electronics Engineering Manager
St. Rita's Medical Center, Lima

Workforce Development Council
Business/Industry/Labor Representatives
Industrial Technician Cluster TCP

Jim Ackerman, Maintenance Technician
Whirlpool Corporation, Clyde

Dallas Bennet, Electrical Designer
Stein, Incorporation, Sandusky

Cindy Chapman, UAW Training Coordinator, Local 913
Delco Chassis, Sandusky

Chris Crump, Plant Superintendent
Style Crest Products, Fremont

David DeHart, ISO-9000 Coordinator Quality Program
Stein, Incorporation, Sandusky

Laura Fitzwater, CIM Engineer
Atlas, Incorporation, Fostoria

Scott Hitchings, Vibration Analysis Team Member/Machine Repairperson
Delco Chassis, Sandusky

Kent Kline, Engineering Manager
Norton Manufacturing Company, Fostoria

Dan Kontak, Maintenance Supervisor
National Machinery Company, Tiffin

David Paul, Manufacturing Engineer
Ford Motor Company, Sandusky

Don Paul, Lead Electrician
Silgan Plastics, Port Clinton

Kate Schrader, Project Engineer/Training Coordinator
Progress Plastic Products, Bellevue

Tony Spieldenner, Quality Engineer for Materials
Whirlpool Corporation, Clyde

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Community and Technical College, University of Akron

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Bob Geis, Engineering & Drafting Instructor
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Allen Smith, Principles of Technology & Machine Trades Instructor
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Dennis Sullivan, Manufacturing Technology Instructor
Community and Technical College, University of Akron

Fred Weiss, Electronics & Fluid Power Mechanic Instructor
East High School, Akron

Clark State Tech Prep Consortium
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Manufacturing Technician TCP

Judith Anderson, English Instructor
Clark State Community College, Springfield

Paul Aukerman, Science/Math/Computer Science Instructor
Mechanicsburg High School, Mechanicsburg

John Bailey, Engineering Technology Instructor
Clark State Community College, Springfield

Alfreda Beaver, Curriculum Consultant
Clark County Schools, Springfield

Bob Brausch, Math/Physics Instructor
South High School, Springfield

Jan Brautigam, Science Instructor
South High School, Springfield

Fred Martin, Mathematics Instructor
Kenton Ridge High Schol, Springfield

Kylene Norman, Mathematics Instructor
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Gene Pitstick, Technology Coordinator
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Kim Poland, English Instructor
Mechanicsburg High School, Mechanicsburg

Christina Pryor, Science Instructor
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Kim Reynolds, English/Reading Instructor
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Clark State Tech Prep Consortium
Education Representatives (continued)
Manufacturing Technician TCP

David Creamer, Industrial Technology Instructor
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Bob DeLong, Science Instructor
Tecumseh High School, New Carlisle

Jeannine Fox, Curriculum Director
Springfield City Schools, Springfield

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South High School, Springfield

Bill Grimpe, Industrial Technology Instructor
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Don Summers, CADD Instructor
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Ken Urbanek, Science Instructor
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Mike Whitmer, Precision Machining Instructor
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Wayne Wiseman, English/Applied Communications Instructor
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Columbiana County Tech Prep Consortium
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Claudia Barrett, Developmental Education Instructor
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Ken Campradt, Physics Instructor
Salem High School, Salem

Robert Chiles, Manufacturing Technolgy Instructor
Kent State University—Salem Campus

Bob Citino, Machine Trades Instructor
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Don Conser, Industrial Arts/Math Instructor
Salem High School, Salem

Lynda Dickson, Physics Instructor
Columbiana County Career Center, Lisbon

Bill Esposito, English Instructor
Salem High School, Salem

Debra Gallo, Mathematics Instructor
Kent State University—Salem Campus

Jeff Gill, Mathematics Instructor
Southern Local, Salineville

Mike Goodballet, English Instructor
East Liverpool High School, East Liverpool

Kathy Green, Mathematics Instructor
Columbiana High School, Columbiana

Ed Grimes, Machine Trades Instructor
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Kathy Johnson, Mathematics Instructor
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Susie Landsettle, Mathematics Instructor
Beaver High School, Lisbon

Gale Meek, Machine Trades Instructor
East Liverpool High School, East Liverpool

Columbiana County Tech Prep Consortium
Education Representatives (continued)
Integrated Manufacturing Technology TCP

Bob Meyers, Electronics Instructor
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Linda Thayer, Drafting/CAD Instructor
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Randy Taylor, Mathematics Instructor
East Liverpool High School, East Liverpool

Mary Van Buren, English Instructor
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Keith Webster, Manufacturing Technology Instructor
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Roger Weekes, Manufacturing Technology Instructor
Kent State University—Salem Campus

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Columbiana High School, Columbiana

Jay Wootten, English Instructor
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Jefferson County Tech Prep Consortium
Education Representatives
Engineering Technology Cluster TCP

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Valerie D'Amico, Mathematics Instructor
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Eric Exley, Engineering Instructor
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Matt Freedman, Mathematics Instructor
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George Fisher, Science Instructor
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Ken Herron, Mathematics Instructor
Indian Creek High School, Wintersville

Roger Hilty, Welding & Fabrication Instructor
Jefferson County Joint Vocational School, Bloomingdale

Tom Horne, Mathematics Instructor
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Jefferson County Tech Prep Consortium
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Engineering Technology Cluster TCP

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Toronto High School, Toronto

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Steubenville High School, Steubenville

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Craig Thompson, English Instructor
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Steve Turner, Math/Engineering Instructor
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Sue Vallera, Engineering Instructor
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Jefferson County Tech Prep Consortium
Education Representatives (continued)
Engineering Technology Cluster TCP

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Buckeye Local High School, Rayland

Rita Zaborek, Mathematics Instructor
Buckeye Local High School, Rayland

Mid-East Ohio Tech Prep Consortium
Education Representatives
Engineering Cluster TCP

Dan Durfee, Science Instructor
Muskingum Technical College, Zanesville

Jeff Gibbs, CADD/Mechanical Engineering Technology Instructor
Muskingum Technical College, Zanesville

Susan Henderson, English Instructor
Muskingum Technical College, Zanesville

Chris Horstman, Industrial Technology Instructor
Meadowbrook High School, Byesville

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Diane Jackson, English Instructor
Zanesville High School, Zanesville

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Tom Spray, Guidance Counselor
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Sheridan High School, Thornville

Laloni Tysinger, Mathematics Instructor
Zanesville High School, Zanesville

Mid-East Ohio Tech Prep Consortium
Education Representatives
Machine Tool, Die & Moldmaking TCP

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North Central Tech Prep Consortium
Education Representatives
Electrical Maintenance TCP

Shelly Barr, Mathematics Instructor
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Ike Costein, Science Instructor
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Pioneer Joint Vocational School, Shelby

Bob Crowl, Machine Technologies Instructor
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Nancy Fry, Mathematics Instructor
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North Central Tech Prep Consortium
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Electrical Maintenance TCP

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North Central Tech Prep Consortium
Education Representatives
Electronics Technician

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Ike Costein, Science Instructor
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Nick Costein, Electronics Instructor
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Bob Crowl, Machine Technologies Instructor
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North Central Tech Prep Consortium
Education Representatives (continued)
Manufacturing Technician TCP

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Nick Costein, Electronics Instructor
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Joseph Mollica, Drafting Instructor
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North Central Tech Prep Consortium
Education Representatives (continued)
Tool and Die Technician TCP

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Cardington-Lincoln High School, Cardington

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Upper Miami Valley Tech Prep Consortium
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Manufacturing Technician TCP

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West Central Tech Prep Consortium
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Van Wert High School, Van Wert

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West Central Tech Prep Consortium
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Manufacturing Engineering Technician TCP

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West Central Tech Prep Consortium
Education Representatives (continued)
Manufacturing Engineering Technician TCP

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West Central Tech Prep Consortium
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Electronic Engineering Technician TCP

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West Central Tech Prep Consortium
Education Representatives (continued)
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TECH PREP
"GET SERIOUS . . . ABOUT SUCCESS"

Sample TCP

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CENTER ON EDUCATION
AND TRAINING FOR EMPLOYMENT
COLLEGE OF EDUCATION
THE OHIO STATE UNIVERSITY

This Sample TCP is in "Accountability Chart" format. [See "The TCP Process" for more information.] The remaining blanks on this chart will be filled in as the Clark State Tech Prep Consortium turns their Manufacturing Technician Tech-Prep Competency Profile into a systemic reform curriculum—a fluid document that will be updated annually with both secondary and postsecondary educators as well as business, industry, and labor representatives taking part.

CLARK STATE TECH-PREP CONSORTIUM

TECH-PREP COMPETENCY PROFILE

May 16, 1994

The Tech-Prep Mission

The Tech-Prep Program will provide students with applied learning opportunities at the secondary and post-secondary level to enable them to compete in a global economy. The Program is a continuum of applied, technical, and lifelong learning skills, educational experiences, and career exploration leading to high-tech careers, through the collaborative efforts of business, industry, labor, schools, and community.

The Tech-Prep Competency Profile
for Manufacturing Technologies
developed by the Clark State Tech-Prep Consortium

The Tech-Prep Competency Profile is the result of extensive collaboration between the industrial and educational communities. This document will provide the foundation for our Tech-Prep course of study from grade 9 through an associate degree.

The grid on page 8 reflects the job classifications within Manufacturing Technologies which were identified by local industry as most in demand in five years. This grid indicates which units will be taught for the five manufacturing technician designations. Generally speaking, all Tech-Prep students will receive a strong core of academics and industrial operations and processes during high school, and will specialize once they reach Clark State.

The units are divided into two categories: academic units (communications, math, science, and technology literacy) and technical units. Academic units show what the state requires of all high school students; an asterisk designates those competencies which industry recommends to be taught in a manufacturing context.

Technical units reflect the competencies recommended by industry, as well as the grade levels when those competencies will be introduced (I), mastered (M), or reinforced(R). A designation of "10," "12," or "AD," indicates delivery by the end of grade 10, 12, or associate degree. "O" indicates subject matter that requires an ongoing learning process (such as in the case of software, which is constantly being updated). "OJT" indicates that the knowledge or skills need to be completed through on-the-job training.

For example, a competency designation of "I10, M12, RAD, O" means that the competency would be introduced by the end of grade ten, mastered by the end of grade 12, reinforced during the associate degree program, and continued on an ongoing basis after graduation.

We would like to express our deepest appreciation to the industries who allowed their employees to spend two full days with us to develop this competency profile. Those companies are listed with their representatives, along with our participating educators, on pages 3-7. We have initiated some excellent dialogue between industry and education, and look forward to continuing and expanding that process.

If you would like additional information about Tech-Prep, please contact us at 328-3888. Thanks again to all those who made this document possible.

Clark State Tech-Prep Consortium
Tech-Prep Competency Profile

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Math

Clark Stewart
Teikuro Corporation, Springfield, Ohio
Production Quality Manager

Don Summers
Springfield-Clark Joint Vocational School, Springfield, Ohio
CADD

George Tomashot
Holophane Company, Inc., Springfield, Ohio
Tool Engineering

Ken Urbanek
Mechanicsburg High School, Mechanicsburg, Ohio
Science

Robert B. VanKuiken
Navistar International Transportation Corp., Springfield, Ohio
General Foreman/Processing Engineer

Jeff Van Zant
Houston Machine, Inc., Springfield, Ohio
Quality/Machine Center

Robert Walder
Clark State Community College, Springfield, Ohio
Engineering Technology Division

Leah Wasserman
Mechanicsburg High School, Mechanicsburg, Ohio
Math

Mike Whitmer
Springfield-Clark Joint Vocational School, Springfield, Ohio
Precision Machining

Mike Williams
Eagle Tool & Machine Company, Inc., Springfield, Ohio
Programming Manager

Wayne Wiseman
Springfield-Clark Joint Vocational School, Springfield, Ohio
English/Applied Communication/Technical Writing

Bill Woodruff
Navistar International Transportation Corp., Springfield, Ohio
Maintenance Electrician

Manufacturing Technician

An individual who applies technical knowledge and skills to a wide range of manufacturing processes and systems.

Specializations at the two-year college level may include

- *Industrial Manufacturing Technician
- *Mechanical Technician
- *Electromechanical Technician
- *CADD Technician
- *Numerical Control Technician

CLARK STATE TECH-PREP CONSORTIUM
TCP DRAFT

IM =	Industrial Manufacturing Technician
MT =	Mechanical Technician
EM =	Electromechanical Technician
CT =	CADD Technician
NC =	Numerical Control Technician

PAGE	Unit	IM	MT	EM	CT	NC
9	Communications Literacy	X	X	X	X	X
18	Mathematics Literacy	X	X	X	X	X
23	Science Literacy	X	X	X	X	X
31	Technology Literacy	X	X	X	X	X
32	Employability Skills	X	X	X	X	X
37	Professionalism	X	X	X	X	X
41	Teamwork	X	X	X	X	X
43	Computer Literacy	X	X	X	X	X
45	Workplace Safety	X	X	X	X	X
47	Quality Assurance	X				X
54	Industrial Manufacturing Technology	X	0	0	0	X
59	Technical Recording and Reporting	X	X	X	X	X
60	Basic Materials Science	X	X			X
67	Welding	X	X	X		X
69	Industrial Electricity	0	0	X		0
74	Basic Electronics			X		
78	Fundamentals of Electronics Technology			X		
84	Troubleshooting and Repair			X		
88	Electrical and Electronic Test and Measurement Equipment			X		
90	Equipment Installation	X	X	X		X
92	Equipment Maintenance	X	X	X		X
96	Wiring Methods			X		
101	Electromechanical Technology			X		
106	Mechanical Power Transmission		X	X		
112	Precision Machining	X	X		X	X
120	Programmable Logic Controllers (PLCs)	X	X	X	X	X
123	Computerized Numerical Control (CNC)	X		X		X
126	Hydraulics and Pneumatics	X	X	X		X
133	Basic Drafting	X	X	X	X	X
138	Fundamentals of CADD Technology				X	
141	Intermediate CADD Technology				X	
144	Advanced CADD Technology				X	
146	CADD Applications				X	

0 = Less Depth

CLARK STATE TECH PREP CONSORTIUM
TECH-PREP COMPETENCY PROFILE
MANUFACTURING TECHNICIAN

September 1994

Academic Literacies

Communications Literacy Page 1
Mathematics Literacy Page 15
Science Literacy Page 23
Technology Literacy Page 36

Key: 10 = by the end of grade 10
12 = by the end of grade 12
AD= by the end of the Associate Degree
O = Ongoing
OJT= On-the-job training

I = Introduce
R = Reinforce
M = Master

it: Communications Literacy (Ohio Language Arts Model 9-12)	10	12	AD	O	OJT
***=Industry identified these to be taught using applied methods #=Teachers identified these to be taught using applied methods Note: The remaining competencies are to be taught using regular or applied methods**					
Subunit: Reading--Structure					
Competencies:					
* Exhibit knowledge of language structure					
* Recognize that there may be more than one interpretation of reading selections					
# Recognize various literary devices					
Recognize and discuss literary elements					
# Develop and use an increasingly sophisticated vocabulary gained through context					
Apply knowledge of language structure to reading					
* Explain why there may be more than one interpretation of reading selections					
# Recognize effect of literacy devices on meaning					
Analyze author's use of literary elements					
* Recognize relationship of structure to meaning					
# Describe various interpretations and meaning levels in reading selections					
Characterize author's use of literary devices					
* Characterize use of library techniques					
Critique a variety of literature with regard to plot, dialogue, theme, setting, and characterization					
* Apply an expanding vocabulary gained through reading					
# Explain various interpretations and meaning levels in reading selections					

Unit: Communications Literacy (Ohio Language Arts Model 9-12)	**10**	**12**	**AD**	**O**	**OJT**
Subunit: Reading--Structure (cont'd.)					
Analyze use of literary techniques (e.g., extended metaphor, simile, personification, hyperbole, pun, alliteration)					
Understand use of literary devices (e.g., irony, satire, allegory, onomatopoeia					
Analyze and synthesize pieces of literature with regard to plot, dialogue, theme, setting, and characterization					
Subunit: Reading--Meaning Construction					
Competencies:					
# Demonstrate ability to recognize appropriate pre-reading strategies					
* Describe effectiveness of a reading selection					
* Read to clarify personal thinking and knowledge					
* Support interpretation of text by locating and citing specific information					
Develop personal response to a variety of literary works					
Recognize diverse literary interpretations					
* Engage in self-selected reading activities					
# Confirm and extend meaning in reading by researching new concepts and facts					
# Self-monitor and apply corrective strategies when communication has been interrupted or lost					
Use features of literary genres to extend meaning					
* Assess effectiveness of a selection read					
* Use reading as a possible problem-solving strategy to clarify personal thinking and knowledge					
# Use knowledge of semantic elements (e.g., figurative language, denotation, connotation, dialect) to clarify meaning when reading					

it: Communications Literacy (Ohio Language Arts Model 9-12)		**10**	**12**	**AD**	**O**	**OJT**
Subunit:	**Reading--Meaning Construction** (cont'd.)					
	Predict, recognize, interpret, and analyze themes based on familiarity with author's work					
	Compare and contrast literary genres					
#	Assess validity and quality of selection read					
*	Clarify meaning when reading					
	Compare personal reaction to critical assessment of a literary selection					
	Assess validity of diverse literary interpretations					
*	Use reference books to find, evaluate, and synthesize information					
#	Identify tone of a literary work					
	Critique validity of diverse literary interpretations					
	Integrate personal reaction to and critical assessment of a literary selection					
Subunit:	**Reading--Application**					
Competencies:						
*	Select and read material for personal enjoyment and information					
	Read a variety of complete, unabridged works					
*	Employ various reading strategies according to purpose					
	Participate in selection of books, materials, and topics for literature study groups					
#	Develop and apply knowledge of the interrelationship of concepts					
#	Read selections from a variety of styles and formats, recognizing that style and format influence meaning					

Unit: Communications Literacy (Ohio Language Arts Model 9-12)		10	12	AD	O	OJT
Subunit: Reading--Application (cont'd.)						
*	Extend value of reading, writing, speaking, viewing, and listening by pursuing, through reading, new concepts and interests developed as a result of these activities					
	Read extensively from a particular author's work and explain elements of author's style					
Subunit: Reading--Multidisciplinary						
Competencies:						
	Connect themes and ideas across disciplines through literature					
#	Read to facilitate learning across curriculum					
	Read to develop awareness of human rights and freedom					
#	Participate actively in a community of learners					
	Recognize and explain interaction between literature and various cultural domains (e.g., social technological, political, economic)					
	Explore and analyze a variety of cultural elements, attitudes, beliefs, and value structures by men and women of many racial, ethnic, and cultural groups					
	Value thinking and language of others					
	Relate literature to historical period about which or in which it was written					
#	Read to facilitate content learning					
Subunit: Writing--Structure						
Competencies:						
#	Develop and expand a repertoire of organizational strategies (e.g., narration, comparison/contrast, and description) through a practice and discussion					
*	Clarify word choice according to audience, topic, and purpose					

	t: Communications Literacy (Ohio Language Arts Model 9-12)	10	12	AD	O	OJT
Subunit:	**Writing--Structure** (cont'd.)					
*	Locate and correct errors in usage, spelling, and mechanics using a variety of resources					
#	Recognize information gained from primary and secondary sources					
*	Develop writing which contains ordered, related, well-developed paragraphs with sentences of varied lengths and patterns					
*	Use information from a variety of sources to develop an integrated piece of writing					
#	Evaluate and revise writing to focus on such things as audience, tone, and purpose					
#	Recognize differences between documentation and reference list styles					
	Develop extended pieces of writing which contain ordered, related, well-developed paragraphs with sentences of varied lengths and patterns					
#	Select from a repertoire of organization strategies a pattern appropriate to a topic					
#	Synthesize information from a variety of sources					
*	Refine word choice and tone according to audience, situation, and purpose					
#	Appropriately cite information gained from primary and secondary sources					
#	Use style manuals or software to prepare documentation and reference lists					
#	Develop effectively organized pieces of expository writing containing strong voice, clear thesis, and well-developed ideas					
#	Identify organization patterns appropriate to writing topic					
	Respond to others' suggested revisions to a writing piece					

Unit: Communications Literacy (Ohio Language Arts Model 9-12)	**10**	**12**	**AD**	**O**	**O**
Subunit: Writing--Meaning Construction					
Competencies:					
# Demonstrate knowledge of the recursive nature of the writing process by applying it appropriately to various topics, situations, and audiences					
# Develop criteria for writing evaluation using scoring guides and peer/teacher assistance to clarify meaning					
* Respond to others' suggested revisions to a piece of writing					
* Use word processing graphics and publishing aids to construct meaning in writing					
# Engage in self-initiated writing activities					
Incorporate personal criteria with generally accepted standards for writing evaluation					
* Evaluate, analyze, and synthesize information for writing					
# Evaluate own writing using personal and established scoring criteria					
# Assess personal/peer revisions to a writing piece					
# Recognize and refine personal writing styles					
Subunit: Writing--Application					
Competencies:					
* Apply appropriate writing techniques suitable for varied writing tasks					
Use sentence-combining techniques to improve syntactic fluency and maturity					
Write in response to prompted and self-selected topics in practical, persuasive, descriptive, narrative, and expository domains					
Develop personal voice in writing					

it: Communications Literacy (Ohio Language Arts Model 9-12)		10	12	AD	O	OJT
Subunit:	**Writing--Application** (cont'd.)					
#	Consider audience and purpose for writing					
	Develop criteria for selection and potential development of topic					
	Write in journal or learning log to clarify personal thinking and knowledge					
#	Apply an expanding vocabulary gained through writing					
*	Make judicious use of reference sources (e.g., dictionary, thesaurus, on-lien data base, encyclopedia)					
	Demonstrate an appreciation for aesthetically pleasing language through word choice and style					
#	Apply revising and editing strategies needed for writing task					
#	Vary sentence lengths and patterns					
	Refine personal voice in writing					
#	Vary styles and formats for intended purpose and audience					
#	Apply criteria for selection and development of topic					
*	Participate in peer review of writing in progress					
#	Use transitions between sentences, ideas, and paragraphs in writing					
#	Revise and edit papers extensively in preparation for presentation/publication					
	Develop a variety of genres					
#	Focus writing and tone on such elements as audience, situation, and purpose					
#	Develop topic fully and appropriately					
	Use writing process to clarify personal thinking and knowledge					
#	Apply appropriate recursive writing process as suggested by writing task and writer's process					

Unit: Communications Literacy (Ohio Language Arts Model 9-12)	**10**	**12**	**AD**	**O**	**OJT**
Subunit: Writing--Application (cont'd.)					
Develop an extended piece of writing					
# Revise writing and tone to assure focus on such elements as audience, situation, and purpose					
Use writing process to write reflectively					
Subunit: Writing--Multidisciplinary					
Competencies:					
# Use writing process for learning across curriculum					
Use writing process to demonstrate knowledge of need for human rights and freedom					
# Value and apply collaborative skills in writing process					
# Write in response to reading, speaking, viewing, and listening					
# Use multicisciplinary resources in writing projects					
# Use writing process to facilitate learning across curriculum					
# Recognize value of and engage in collaboration in writing process					
# Use communication processes to develop a published writing piece in collaboration with others					
* Record experiences and observations related to content learning					
Apply collaborative skills in writing process					
# Write collaboratively with peers					
# Use cross-disciplinary resources in writing projects					
Subunit: Listening/Visual Literacy--Structure					
Competencies:					
Listen to and view a wide variety of genres					

it: Communications Literacy (Ohio Language Arts Model 9-12)	**10**	**12**	**AD**	**O**	**OJT**
Subunit: Listening/Visual Literacy--Structure (cont'd.)					
Become aware of an author's style through listening and viewing a variety of works					
* Recognize correct and appropriate grammar, diction, and syntax					
* Expand vocabulary through listening to and viewing varied media					
Recognize beauty of language					
Enhance recognition of an author's style through listening and viewing a variety of works					
Recognize use and misuse of language in media					
Refine knowledge of style through listening and viewing multiple works by the same author					
Expand and refine grammar, diction, and syntax through listening					
Compare authors' styles through viewing and listening to their works					
Expand knowledge of complex grammar, diction, and syntax issues					
Subunit: Listening/Visual Literacy--Meaning Construction					
Competencies:					
* Develop critical thinking skills necessary to evaluate media and assess oral presentations					
Compare new oral texts to past experiences and knowledge in order to enhance comprehension					
# Recognize how rhythmic patterns, silence, and cadences enhance quality of speech and literature					
Focus listening and viewing on themes and/or plots					

Unit: Communications Literacy (Ohio Language Arts Model 9-12)	**10**	**12**	**AD**	**O**	**OJT**
Subunit: Listening/Visual Literary--Meaning Construction (cont'd.)					
* Gather information from listening and viewing experiences to enhance research					
# Use critical thinking skills to evaluate media and oral presentations					
Use prior knowledge and experiences to facilitate comprehension of new oral texts					
Identify rhythmic and time patterns in speech and literature					
Identify and analyze themes and/or plots when listening and viewing					
Use information gathered from listening and viewing experiences to expand research					
Enhance use of critical thinking skills to evaluate media and oral presentations					
Consider prior knowledge and experiences when attempting to understand the meaning of new texts					
Appreciate rhythmic and time patterns of speech and literature					
# Select viewing and listening materials to support written text					
# Evaluate media and oral presentations analytically and critically					
# Organize prior knowledge and experiences to comprehend new texts					
Organize and use viewing and listening materials to support written text					
Subunit: Listening/Visual Literacy--Application					
Competencies:					
* Listen attentively during oral reading					
# Use media as stimuli for learning and thinking					

	t: Communications Literacy (Ohio Language Arts Model 9-12)	10	12	AD	O	OJT
Subunit:	**Listening/Visual Literacy--Application**					
#	Develop knowledge of structure through art, music, and literature					
	Use electronic media to enhance and highlight language learning					
	Listen and view for entertainment and enjoyment					
#	Use technology and other media as means of expressing ideas					
Subunit:	**Listening/Visual Literacy--Multicisciplinary**					
Competencies:						
#	Facilitate learning across curriculum through critical listening and viewing					
*	Engage in individual, small-group, and whole-group listening and viewing activities					
	Develop language arts (e.g., viewing, listening) projects collaboratively					
	Investigate language and cultural differences through listening and viewing activities					
#	Participate in a community of learners through productive listening					
Subunit:	**Oral Communication--Structure**					
Competencies:						
*	Refine oral communication skills					
#	Demonstrate knowledge of grammar, usage, and syntax when presenting					
#	Select topics and vocabulary suitable to audience					
*	Organize notes and ideas for speaking					
#	Use language imaginatively					
	Modulate voice to meaning when interpreting literature orally					

Unit: Communications Literacy **(Ohio Language Arts Model 9-12)**	**10**	**12**	**AD**	**O**	**O**
Subunit: Oral Communication--Structure (cont'd.)					
* Organize notes and ideas for formal, semiformal, and informal presentations of information					
# Refine speaking techniques for formal, semiformal, and informal settings					
# Develop repertoire of organizational strategies for presenting information orally					
# Expand vocabulary to fit topic					
* Select topics suitable to audience, situation, and purpose					
* Select appropriate strategies when organizing notes and ideas for speaking					
Subunit: Oral Communications--Meaning Construction					
Competencies:					
* Make connections between prior knowledge and new information for oral presentations					
* Participate in informal speaking activities					
* Use interviewing techniques to gather information					
* Communicate orally to entertain and to inform					
Participate in group communication activities					
* Take and organize notes when preparing speech/presentation					
* Interpret texts orally to illustrate meaning					
# Respond to needs of various audiences					
* Gather and assess information for speaking					
* Communicate orally to inform and persuade					
# Prepare and deliver formal speech/presentation					
Participate in a variety of oral interpretations					

it: Communications Literacy (Ohio Language Arts Model 9-12)		10	12	AD	O	OJT
Subunit:	**Oral Communications--Meaning Construction (cont'd.)**					
#	Assess needs of audience and adjust language and presentation according to their knowledge					
#	Analyze and synthesize information for speaking					
	Describe effectiveness of literary selection					
#	Describe topic or idea in order to clarify personal/audience thinking					
#	Analyze and synthesize information gathered from a variety of sources for speaking					
	Describe validity and/or quality of a literary selection and justify selection					
	Interpret orally a variety of literature					
	Describe topic or idea to clarify meaning for others					
Subunit:	**Oral Communication--Application**					
Competencies:						
*	Become proficient at using interviewing techniques					
*	Give an oral interpretation for a specific audience					
*	Develop and apply oral communication skills for cooperative/collaborative learning					
#	Use oral communication for a variety of purposes and audiences (e.g., negotiations, book reviews, rationales)					
*	Develop and apply decision-making strategies					
#	Practice interviewing techniques					
#	Apply interviewing techniques to purposeful interviews					
#	Focus oral interpretation on a specific audience					

Unit: Communications Literacy (Ohio Language Arts Model 9-12)	**10**	**12**	**AD**	**O**	**OJT**
Subunit: Oral Communications--Multidisciplinary					
Competencies:					
# Value thinking and language of others					
# Develop oral projects collaboratively					
# Be involved in individual, small-group, and whole-group language activities					
# Participate actively in a community of learners					
# Investigate language and cultural differences through oral language activities					

it: Mathematics Literacy (Ohio's Mathematics Model 9-12)	10	12	AD	O	OJT
***=Industry identified these to be taught using applied methods #=Teachers identified these to be taught using applied methods Note: The remaining competencies are to be taught using regular or applied methods**					
Subunit: Number and Number Relations					
Competencies:					
* Compare, order, and determine equivalence of real numbers					
* Estimate answers, compute, and solve problems involving real numbers					
* Compare and contrast real number system, rational number system, and whole number system					
Extend knowledge to complex number system and develop facility with its operation					
unit: Measurement					
Competencies:					
* Estimate and use measurements (stressing metrics)					
* Understand need for measurement and probability that any measurement is accurate to some designated specification					
* Understand and apply measurements related to power and work					
* Understand and apply measurement concepts of distance-rate-time problems and acceleration problems					
* Use real experiments to investigate elasticity, heat, sound, electricity, magnetism, light, acceleration, velocity, energy, and gravity					
* Use real-world problem situations involving mass and weight					
Use real-world problem situations involving simple harmonic motion					
* Establish ratios with and without common units					

Unit: Mathematics Literacy (Ohio's Mathematics Model 9-12)	10	12	AD	O	OJT
Subunit: Measurement (cont'd.)					
* Construct and interpret maps, tables, charts, and graphs as they relate to real-world mathematics					
* Understand and solve rate-change problems					
* Understand and solve right triangle relationships as they relate to measurement, specifically to Pythagorean theorem					
# Graph and interpret ordered pairs					
Compute total sales from a variety of items					
# Comprehend and compute rates of growth or decay					
Comprehend, compute, and interpret real problems involving annuities					
* Develop an ability to identify real problems and provide possible solutions					
* Express and apply different types of measurement scales					
* Identify area and volume					
Subunit: Estimation and Mental Computation					
Competencies:					
Use estimation to eliminate choices in multiple-choice tests					
* Use estimation to determine reasonableness of problem situations in a wide variety of applications					
* Estimate shape of graphs of various functions and algebraic expressions					
* Use mental computation when computer and calculator are inappropriate					
Subunit: Data Analysis and Probability					
Competencies:					
* Organize data into tables, charts, and graphs					

it: Mathematics Literacy (Ohio's Mathematics Model 9-12)	10	12	AD	O	OJT
Subunit: Data Analysis and Probability (cont'd.)					
* Understand and apply measures of central tendency, variability, and correlation					
* Use curve fitting to predict from data					
# Use experimental or theoretical probability, as appropriate, to represent and solve problems involving uncertainty					
Use computer simulations and random generators to estimate probabilities					
# Test hypotheses using appropriate statistics					
* Read, interpret, and use tables, charts, and graphs to identify patterns, note trends, draw conclusions, and make predictions					
Identify probabilities of events involving unbiased objects					
Use sampling and recognize its role in statistical claims					
Design a statistical experiment to study problem, conduct experiment, and interpret and communicate outcomes					
# Describe normal curve in general terms and use its properties					
Create and interpret discrete probability distributions					
Understand concept of random variable					
Apply concept of random variable to generate and interpret probability distributions, including binomial, uniform, and chi square.					
Subunit: Algebra					
Competencies:					
* Describe problem situations by using and relating numerical, symbolic, and graphical representations					
Use language and notation of functions in symbolic and graphing settings					

Unit: Mathematics Literacy (Ohio's Mathematics Model 9-12)	10	12	AD	O	OJT
Subunit: Algebra (cont'd.)					
Recognize and use equivalent zeros of a function, roots and the solution of an equation in terms of graphical and symbolic representations					
Describe and use logic of equivalence in working with equations, inequalities, and functions					
Develop graphical techniques of solution for problem situations involving functions					
Explore and describe characterizing features of functions					
* Make arguments and proofs in algebraic settings					
# Factor difference of two squares					
Identify slope, midpoint, and distance					
Explore and combine rational functions					
Explore factoring techniques					
Solve quadratic equations by factoring and formula					
* Set up and solve linear equations					
* Solve systems of linear equations with two variables					
* Describe geometric situations and phenomena using variables, equations, and functions					
# Describe measures of central tendency, mean, median, mode, and variance algebraically and graphically					
Represent inequalities on number line and in coordinate plane					
Use coordinate arguments in making geometric proofs					
Symbolize transformations of figures and graphs					
# Explore geometric basis for functions of trigonometry					
Graph linear functions					
Develop and use vectors to represent direction and magnitude including operations					

it: Mathematics Literacy (Ohio's Mathematics Model 9-12)	10	12	AD	O	OJT
Subunit: Algebra (cont'd.)					
# Use polar and parametric equations to describe, graph and solve problem situations					
Represent sequences and series as functions both algebraically and graphically					
Explore recursive functions and procedures using spreadsheets, other computer utilities, and appropriate notions					
Describe and solve algebraic situations with matrices					
Describe and use inverse relationship between functions including exponential and logarithmic					
Analyze and describe errors and error sources that can be made when using computers and calculators to solve problems					
# Decide whether problem situation is best solved using computer, calculator, paper and pencil, or mental arithmetic/estimation techniques					
Explore relationships between complex numbers and vectors					
Make arguments concerning limits, convergence and divergence in context involving sequences, series, and other types of functions					
Represent transformations in plane with matrices					
Contrast and compare algebra's of rational, real, and complex numbers with characteristics of a matrix algebra system					
Construct polynomial approximations of a function over specified intervals of convergence					
Examine complex numbers as zeros of functions					
# Translate verbal statements into symbolic language					
* Simplify algebraic expressions					
# Use laws and exponents (including scientific notation)					

Unit: Mathematics Literacy (Ohio's Mathematics Model 9-12)	**10**	**12**	**AD**	**O**	**OJT**
Subunit: Algebra (cont'd.)					
Expand and extend idea of vectors and linear algebra to higher dimensional situations					
Use the idea of independent basis elements for a vector space and associated fundamental concepts of finite dimensional linear algebra					
Develop and communicate arguments about limit situations					
Use matrices to describe and apply transformations					
Develop and use polar and parametric equations to represent problem situations					
Explore proofs by mathematical induction					
Subunit: Geometry					
Competencies:					
* Create and interpret drawings of three-dimensional objects					
* Represent problem situations with geometric models and apply properties of figures					
* Apply Pythagorean theorem					
* Demonstrate knowledge of angles and parallel and perpendicular lines					
* Explore inductive and deductive reasoning through applications to various subject areas					
Translate between synthetic and coordinate representations					
# Identify congruent and similar figures using transformation with computer programs					
Deduce properties of figures using transformations and coordinates					
* Use deductive reasoning					
# Explore compass and straightedge constructions in context of geometric theorems					

it: Mathematics Literacy (Ohio's Mathematics Model 9-12)		10	12	AD	O	OJT
Subunit: Geometry (cont'd.)						
#	Demonstrate knowledge of and ability to use proof					
	Use variety of proof techniques (e.g., synthetic, transformational, and coordinate)					
	Use variety of proof formats, including T-proof, (i.e., two-column) and paragraph proof					
	Explore different proof strategies					
	Investigate different proofs of theorems					
	Develop knowledge of an axiomatic system					
#	Apply transformations and coordinates in problem solving					
*	Represent problem situations with geometric models and apply properties of figures					
	Deduce properties of figures using vectors					
	Analyze properties of Euclidean transformations and relate translations to vectors					
	Apply vectors in problem solving					
	Develop further knowledge of axiomatic systems by investigating and comparing various geometry's					
Subunit: Patterns, Relations, and Functions						
Competencies:						
	Model real-world phenomena with polynomial and exponential functions					
	Explore relationship between zeros and intercepts of functions					
#	Translate among tables, algebraic expressions, and graphs of functions					
#	Use graphing calculator or computer to generate graph of a function					
	Explore relationship between a linear function and its inverse					

	Unit: Mathematics Literacy (Ohio's Mathematics Model 9-12)	**10**	**12**	**AD**	**O**	**OJT**
	Subunit: Patterns, Relations, and Functions (cont'd.)					
	Describe and use characteristics of polynomial functions in problem-solving situations					
	Explore conic sections and graph using graphing calculator or computer					
*	Apply trigonometric functions to problem situations involving triangles					
	Discover relationships between algebraic description, kind and properties of conic					
#	Explore periodic real-world phenomena using sine and cosine functions					
#	Analyze effects of parameter changes on graphs					
	Use graphing calculator or computer to graph functions					
	Develop an knowledge of rational and transcendental functions					
#	Understand connections between trigonometric and circular functions					
	Use circular functions to model periodic real-world functions					
#	Solve trigonometric equations and verify trigonometric identities					
#	Understand connections between trigonometric, exponential, and logarithmic functions and polar coordinates, complex numbers, and series					
#	Model real-world phenomena with a variety of functions					
#	Graph using polar coordinates					
#	Explore graphs in three dimensions					
	Explore functions of several variables					
	Explore recursive functions using spreadsheets and/or programming languages					

it: Science Literacy (Ohio's Science DRAFT 9-12)	10	12	AD	O	OJT
*=Industry identified these to be taught using applied methods #=Teachers identified these to be taught using applied methods Note: The remaining competencies are to be taught using regular or applied methods					
Subunit: Scientific Inquiry					
Competencies:					
* Check the appropriateness and accuracy of measures and computations using various strategies (e.g., estimations, unit analysis, determination of significant figures)					
* Use ratios, proportions, and probabilities in appropriate problem situations					
* Translate information from and represent information in various forms with equal ease (e.g., tables, charts, graphs, diagrams, geometric figures)					
Use existing algebraic formulas and create new ones in appropriate problem-solving situations					
# Estimate and justify probabilities of outcomes of familiar situations based on experimentation and other strategies					
* Invent apparatus and mechanical tools needed to perform unique tasks in various situations					
Identify, compare, and contrast different modes of inquiry, habits of mind, and attitudes and dispositions					
# Design investigations that are safe and ethical (i.e., obtain consent and inform others of potential outcomes, risks and benefits, and show evidence of concern for human health and safety, concern for non-human species)					
* Make and read scale drawings, maps, models, and other presentations to aid planning and understanding					
# Seek elaboration and justification of data and ideas, and reflect on alternative interpretations of the information					
* Utilize appropriate units for counts and measures					

Subunit:	**Scientific Inquiry (cont'd.)**					
*	Create and use databases (electronic and other) to collect, organize, and verify data and observations					
*	Design and conduct investigations with multiple variables					
*	Communicate the results of investigations clearly in a variety of situations					
	Examine relationships in nature, offer alternative explanations for the observations, and collect evidence that can be sued to help judge among explanations					
	Trace the development (e.g., history, controversy, and ramifications) of various theories, focusing on supporting evidence and modification with new evidence					
#	Select, invent, and use tools, including analog and digital instruments, to make and record direct measurements					
	Observe and document events and characteristics of complex systems					
#	Explain the influence of perspective (e.g., spatial, temporal, and social) on observation and subsequent interpretations					
#	Create multiple representations of the same data using a variety of symbols, descriptive languages, mathematical concepts, and graphic techniques					
#	Use existing testable hypotheses for observations of complex systems and interactions					
#	Document potentially hazardous conditions and associated risks in selected homes and public areas					
	Participate in public debates, relying on documented and verified data to construct and represent a position on scientific issues					
#	Construct and test models of physical, biological, social and geological systems					
#	Read, verify, debate and, where necessary, refute research published in popular or technical journals of science (e.g., *Discover, Omni, Popular Mechanics*)					

unit:	**Scientific Inquiry (cont'd.)**					
	Explore discrepant events and develop and test explanations of what was observed					
	Conduct theory-based research using surveys, observational instruments, and other methods					
*	Modify personal opinions, interpretations, explanations, and conclusions based on new information					
#	Analyze error and develop explanations in various domains					
	Formulate taxonomic schemes based upon multivariate models that help to explain similarities and differences in form, distribution, behavior, survival, and origin of objects and organisms					
#	Demonstrate various logical connections between related concepts (e.g., entropy, conservation of energy)					
*	Account for discrepancies between theories and observations					
	Analyze the changes within a system when inputs, outputs, and interactions are altered					
*	Create, standardize, and document procedures					
	Determine the sources of significant disparities between the predicted and recorded results and change research procedures to minimize disparities					
	Research, locate, and propose applications for abstract patterns (e.g., fractals, Fibonacci sequences, string theory, orbitals)					
	Recognize and utilize classification systems for particles, elements, compounds, phenomena, organisms, and others for exploring and predicting properties and behaviors					
#	Suggest and defend alternative experimental designs and data explanations (e.g., sampling, controls, safeguards)					
	Recognize and communicate differences between questions that can be investigated in a scientific way and those that rely on other ways of knowing					
#	Draw conclusions based on the relationships among data analysis, experimental design, and possible models and theories					

Subunit:	**Scientific Inquiry (cont'd.)**					
#	Suggest new questions as a result of reflection on and discussions about their own scientific investigations					
	Investigate, assess, and comment on strengths and weakness of the descriptive and predictive powers of science					
	Create new information from representations of data in a variety of forms (e.g., symbols, descriptive languages, graphic formats) utilizing a variety of techniques (e.g., interpolations, extrapolations, linear regressions, central tendencies, correlations)					
Subunit:	**Scientific Knowledge**					
Competencies:						
	Investigate various types of dynamic equilibrium (e.g., biological, geological, mechanical, chemical)					
#	Investigate the relationship between the rates of energy exchange and the relative energy level of components with systems (e.g., trophic levels of ecosystems, osmosis, rate of heating and cooling, storms)					
#	Investigate patterns in the natural world (e.g., heredity, crystalline structures, population and resource distributions, diffraction, dispersion, polarization)					
#	Investigate models and theories that help to explain the interactions of components in systems (e.g., conservation of mass, energy, and momentum; foodwebs; natural selection; entropy; plate tectonics; chaos, relativity; social-psychology)					
	Investigate degrees of kinship among organisms and groups of organisms					
	Investigate the limits of the definition of life, and investigate organisms and physical systems that exist at or near these limits (e.g., viruses, quarks, black holes)					
#	Investigate estimates and measurements of a wide range of distances and rates of change					
	Investigate the historical development of theories of change over time (e.g., natural selection, continental drift, the big bang, geologic change)					

unit: Scientific Knowledge (cont'd.)					
Investigate physical and chemical changes in living and non-living systems (e.g., photosynthesis, weathering processes, glaciation, thermal effects of materials, energy cells)					
Investigate simulations of nuclear change (e.g., radioactivity, half life, carbon dating)					
Investigate conservation principles associated with physical, chemical, and nuclear changes					
Formulate descriptions of the impacts of various forms of mechanical and electromagnetic waves on various organisms on each other over time					
Formulate models and hypotheses for patterns in the natural world (e.g., earth structures, transportation systems, migrations, communications, constellations)					
Formulate explanations for the influences of objects and organisms on each other over time					
Formulate and interpret explanations for change phenomena (e.g., mass extinctions, stellar evolution, punctuated equilibrium, molecular synthesis)					
Formulate and interpret explanations for the magnitudes of diversity at different periods of geologic time (e.g., mutation, global cataclysms, continental drift, competition, mass extinctions)					
Formulate interpretations of the structure, function and diversity in a variety of organisms and physical systems (e.g., DNA and RNA variants, nucleons, interaction particles)					
Formulate understandings of geologic time (e.g., millennia, periods, epochs)					
Formulate an understanding of the historical development of the model of the universe					
# Formulate explanations and representations of the production, transmission, and conservation of energy in biological and physical systems (e.g., weather, volcanism, earthquakes, electricity, magnetism, cellular respiration)					

Subunit: Scientific Knowledge (cont'd.)					
Formulate models and hypotheses about patterns in the natural world (e.g., social behavior, molecular structure, energy transformation, entropy, randomness, aging, chaos, hormonal cycles)					
# Formulate interpretations of the relationship between energy exchange and the interfaces between components within systems					
Formulate estimations for the range of energies within and between various phenomena (e.g., thermal, electromagnetic, thermonuclear, chemical, electrical)					
Formulate explanations for the historical development of descriptions of motions interactions and transformations of matter and energy (e.g., classical Newtonian mechanics, special and general relativity, chaos)					
Formulate models that can be used to describe fundamental molecular interactions in living and non-living systems (e.g., cell membranes, semiconductors)					
Formulate an understanding of the degree of relationship among organisms and objects based on molecular structure (e.g., proteins, nucleic acids					
# Formulate hypotheses and models that may account for observable events (e.g., electricity and magnetism, gravitation, atoms, bonding, chemical reactions, quantum effects, energy flow on biological systems, predator-prey relationships)					
# Formulate models and hypotheses about change over time (e.g., natural selection, speciation, punctuated equilibrium, phyleytic gradualism, stellar evolution, plate tectonics, radioactive decay, quantum mechanical theory)					
Formulate lists of limitations and propose refinements of standard classification systems (e.g., periodic table, IUPAC, Linnean, standard model)					

unit: Scientific Knowledge (cont'd.)						
#	Formulate specific cases of limitations and possible exceptions of theories and principles regarding the interactions of moving objects and organisms (e.g., fluid flow in vessels, motion near the speed of light, Heisenberg uncertainty principle, meteorological prediction, local variation and diversity, predicting earthquakes, energy transport in cellular respiration)					
#	Formulate plans and contingencies that can be used to accommodate for changes to and stresses on systems (e.g., wildlife and habitat management, corrosion prevention, noise abatement, structure design)					
	Formulate models of molecular, atomic, ionic, and subatomic structures and the physical and biological implications of these structures (e.g., genes, nucleons, quarks)					
#	Formulate estimates for a wide range of measurements and scales (e.g., angstroms to light years)					
	Formulate and interpret representations of time from origin to present accounting for phenomena of scale (e.g., smoothness, punctuations, chaos)					
	Formulate interpretations of the historical development of various theories of possible causes of diversity among physical and biological phenomena (e.g., the works of Aristotle, Mendel, Darwin, McClintock)					
#	Formulate models and hypotheses that can be used to explain the interactions of components within technological and ecological systems					
Subunits: Conditions for Learning Science						
Competencies:						
#	Participate actively in dialogue about and resolution of community issues					
	Assess information from various countries in the original language or translated form to ascertain the perspectives of many cultures					
	Analyze the scientific ideas presented in science fiction stories and films					

Subunits: Conditions for Learning Science (cont'd.)					
# Perform and repeat investigations to verify data, determine regularity, and reduce the impact of experimental error					
# Present the results of investigations in a variety of forums					
Contribute to the decisions regarding topics for investigation					
Use various creative means to communicate interpretations of scientific ideas, concepts, phenomena, and events					
# Consider the scientific thinking and language of others					
# Individually and collaboratively produce clearly written representations of investigative results					
Fulfill responsibilities as part of a research group					
Select and utilize resources by various criteria (e.g., efficiency, effectiveness, health, safety) that are appropriate to the investigations being conducted by groups					
Present persuasive argument based on the scientific aspects of controversial issues					
# Collect, store, retrieve, and manipulate information with available technologies that may range from hand processes up through computer applications					
# Investigate social issues with scientific perspective (e.g., human rights, wellness, economics, futurism, environmental ethics)					
# Keep journals of observations and inferences made over an extended period of time and reflecting upon the impact of these recorded ideas on their thinking and actions					
Examine the intellect, perspectives, and ethics of notable scientists					
Collect and analyze observations made over extended periods of time and compare these to scientific theories					
# Create presentations of scientific understanding using diverse modes of expressions					
Conduct formal scientific debates in the classroom					

	units: Conditions for Learning Science (cont'd.)					
	Wonder about the likelihood of events that may occur by chance or coincidence					
#	Plan and conduct field trips and experiences for small and large groups					
	Analyze the historical context which leads to and has lead to scientific theories					
	Seek information on topic of personal scientific interest from a variety of sources					
	Conduct learner-developed investigations independently and collaboratively over periods of weeks and months					
#	Listen attentively and critically to presentations of scientific information made by others					
	Conduct analyses of propaganda related to scientific issues					
#	Perform investigations that require observations over varying periods of time					
	Experience scientific concepts as interpreted by other cultures through multimedia and local and global specialists					
#	Access appropriate technology to perform complicated, time-consuming tasks					
	Relate historical accounts of science to the cultural context in which they were written					
#	Work as a contributing member of a collaborative research group					
	Examine the influences of social and political structures and realities that contribute to inquiry about scientific issues					
#	Use technology (e.g., desktop publishing, teleconferencing, networking) to communicate scientific ideas					
#	Explore and analyze a variety of perspectives on science (e.g., works by men and women of many racial, ethnic, and cultural groups)					
	Lead groups of learners of various ages in designing, planning, and conducting science activities					

Subunits: Conditions for Learning Science (cont'd.)					
Respect the scientific thinking of others and self					
Recognize and contrast different epistemologies					
Develop possible courses of action in response to scientific issues of local and global concern					
Determine the validity of research conclusions in relation to the design, performance, and results					
# Develop multimedia presentations of group and individual research projects and investigations appropriate for a variety of audiences and forums					
Produce interesting and scientifically correct stories and present them using various modes of expression					
# Reflect on the ideas and content found in their own journal records					
Examine ambiguous results and formulate explanations					
Recognize and synthesize the contributions to scientific thought of individuals from many cultures					
Construct models and simulations of the component structures and functions of living and non-living entities					
Lead multi-age groups in the examination of and planned resolution for scientific issues					
# Recognize and choose members of research teams based upon the merit of their ideas and skills					
# Construct a portfolio of products, documentation, and self-evaluations of his/her own abilities, skills, and experiences					
Synthesize scientific information from a variety of sources					
Evaluate and prioritize scientific issues based upon risk-benefit analyses					
# Refining scientific skills from a variety of experiences					

unit:	**Applications for Science Learning**					
Competencies:						
	Answer student-determined questions by designing databases and drawing inferences from the analyses of the information in these data bases					
#	Make personal behavior decisions by interpreting information that has a scientific basis					
	Propose courses of action that will validate and demonstrate personal understandings of scientific principles					
	Guide other learners in their understanding of the interactions of technologies and society at various periods in time					
	Promote and carry out practices that contribute to a sustainable environment					
	Study and propose improvements in public services and systems in their community					
	Choose consumer materials utilizing personal and environmental risk and benefit information					
*	Make inferences and draw conclusions using databases, spreadsheets, and other technologies					
*	Do simple trouble-shooting on common electrical and mechanical systems, identifying and eliminating possible causes of malfunctions					
*	Construct devices that perform simple, repetitive actions					
*	Investigate the functionality of various geometric shapes in the natural world and the designed world (e.g., translations from spherical to plan representations cause distortions, triangular shapes contribute to rigidity and stability in structures, round shapes minimize boundary for a given capacity)					
*	Make decisions regarding personal and public health					
	Evaluate the social and ecological risks and benefits resulting from the use of various consumer products					
	Analyze the contributions of advances in technology through history to his/her everyday life					

Subunit:	**Applications for Science Learning (cont'd.)**					
	Identify and reduce risks and threats to a sustainable environment					
*	Extend the limits of human capabilities using technological enhancements					
	Use and recognize various propaganda techniques					
*	Solve unique problems using the results of systematic analyses					
	Choose everyday consumer products that utilize recent innovative and pass appropriate performance criteria					
#	Refine personal career interests through investigations of the diversity of manufacturing, research, service, and invention processes					
#	Predict and investigate the working of toys and tools while controlling and manipulating variables (e.g., friction, gravity, forces)					
#	Write, follow, modify, and extend instructions (e.g., equations, algorithms, formulas, flow diagrams, illustrations)					
#	Create products, make inferences, and draw conclusions using databases, spreadsheets, and other technologies					
	Predict various scenarios and propose solutions to community issues using scientific information (e.g., actuarial tables, census data, topographic maps, incidence data, climatic data)					
#	Use scientific evidence to consider options and formulate positions about the health and safety of others and him/herself					
	Search for, use, create, and store objects and information using various strategies and methods of organization and access					
	Research and write environmental impact statements of his/her own design					
	Compare school-based science perspectives with those gained through cutting-edge technological applications					
#	Design management plans for natural and human-altered environments (e.g., woodlots, patios, lots, lawns, farmlands, forests)					

	bunit: Applications for Science Learning (cont'd.)					
	Refine personal career interests					
	Promote public awareness of the interaction of technology with social issues					
#	Advocate and propose courses of action for local and global scientific issues using global networks					
*	Use appropriate technologies to prepare and present the findings of investigations incorporating tables, graphs, diagrams, and text					
#	Make informed consumer choices by evaluating and prioritizing information, evidence, and strategies					
#	Develop an informed point-of view that allows for validation or refutation of the scientific statements and claims of advocated before pursuing courses of action (e.g., contributing support, signing petitions, casting votes)					
#	Differentiate between observations and inferences in the exploration of evidence related to personal, scientific, and community issues					
#	Develop and write environmental impact and safety and hygiene management plans					
#	Use technology to collect, analyze, and communicate information (e.g., electronic networks, desktop publishing, remote sensing, graphing calculators, satellite telemetry, and others)					
#	Design, construct, and market inventions					

Unit: Technology Literacy					
***=Industry identified these to be taught using applied methods** **#=Teachers identified these to be taught using applied methods** **@=Emphasis** **Note: The remaining competencies are to be taught using regular or applied methods**					
Competencies:					
# Demonstrate a systems view of technology based on the interdependence of social, political, economic, and ecological systems					
Assess the career, family, and personal development implications of technological change					
* Demonstrate continuous learning via technology					
@ Demonstrate global appreciation for technology's potential effects on cultures, geographic areas, and the environment					
@ Apply historical perspective on technology to the development and use of new technologies					
Apply diverse technologies to store, access, process, create, and communicate information needed to solve problems					
# Apply legal principles and ethical conduct to the use of technology					
* Demonstrate competency in mathematics, science, social sciences, communication, and computer skills through the analysis, design, and evaluation of technological systems					
Analyze the potential of alternative technological systems to solve problems and/or to extend human capabilities					
* Use a variety of tools, materials, and equipment in solving problems and extending human capabilities					
Assess risks and benefits of technological developments from an ecological, economic, social, and political perspective					
# Value human diversity as part of a team in suggesting, designing, and testing solutions to technological problems					

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it: Employability Skills		**10**	**12**	**AD**	**O**	**OJT**
Competency:	**Develop a career plan**	**I**	**R**	**R**	**O**	
Builders:	Identify current interests and aptitudes					
	Identify common barriers to employment					
	Describe strategies to overcome employment barriers					
	Locate resources for finding employment					
	Research job trends					
	Identify career options					
	Identify advantages and disadvantages of career options					
	Identify job requirements					
	Investigate education/training opportunities					
	Differentiate between career (pay for experience/knowledge) and job (pay for performing specific task)					
mpetency:	**Prepare for employment**	**I**	**M**	**R**	**O**	
Builders:	Identify traditional and non-traditional employment sources					
	Identify present and future employment opportunities					
	Research job opportunities, including non-traditional careers					
	Compare salary ranges and benefit packages					
	Compile occupational profile					
	Identify rights and responsibilities of equal employment opportunity laws					
	Design resume and cover letter					
	Target resume					
	Secure references					

Unit: Employability Skills		**10**	**12**	**AD**	**O**	**OJT**
	Investigate generic and specific employment tests (e.g., civil service exam, drug screening)					
	Use follow-up techniques to enhance employment potential					
	Demonstrate legible written communication skills using correct grammar, spelling, punctuation, and concise wording					
	Describe methods for handling illegal questions on job application forms and during interviews					
	Write letter of application					
	Investigate prospective employer					
	Explain critical importance of personal appearance, hygiene, and demeanor					
	Interpret job description					
	Demonstrate appropriate interview question and answer techniques					
	Demonstrate methods for handling difficult interview questions					
	Evaluate job offers					
	Write letter of acceptance					
	Write letter of declination					
Competency:	**Evaluate positive self-esteem**	**I**	**R**	**R**	**O**	
Builders:	Identify factors that affect self-esteem					
	Compare effects of low self-esteem and high self-esteem					
	Identify strategies to promote positive self-esteem					
Competency:	**Prepare personal budget**	**I**	**R**	**R**	**O**	
Builders:	Describe need for personal management records					
	Balance checkbook					

it: Employability Skills		**10**	**12**	**AD**	**O**	**OJT**
	Identify tax obligations					
	Analyze how credit affects financial security					
	Compare types and methods of investments					
	Compare types and methods of borrowing					
	Compare types and methods of insurance					
	Compare types of retirement options/plans					
	Identify discriminatory vs. non-discriminatory expenditures					
	Explain time-value of money (i.e., compounding of interest)					
Competency:	**Demonstrate job retention skills**					
Builders:	Identify employer expectations regarding job performance, work habits, attitudes, personal appearance, and hygiene					
	Exhibit appropriate work habits and attitude					
	Demonstrate ability to set priorities					
	Identify behaviors to establish successful working relationships					
	Identify alternatives for dealing with harassment, bias, and discrimination based on race, color, national origin, sex, religion, handicap, or age					
	Identify opportunities for advancement					
	List reasons for termination					
	List consequences of being absent frequently from job					
	List consequences of frequently arriving late for work					
	Demonstrate interpersonal relations skills					
	Demonstrate negotiation skills					
	Demonstrate teamwork					

Unit: Employability Skills		**10**	**12**	**AD**	**O**	**OJT**
	Follow chain-of-command					
Competency:	**Demonstrate knowledge of work ethic**	I	M			
Builders:	Define work ethic					
	Identify factors that influence work ethic					
	Differentiate between law and ethics					
	Describe how personal values are reflected in work ethic					
	Describe how interactions in the workplace affect personal work ethic					
	Describe how life changes affect personal work ethic					
Competency:	**Exhibit characteristics that reflect appropriate work ethic**	I	R	R	O	
Builders:	Use time-management techniques					
	Avoid personal activity during work hours					
	Attend work as scheduled					
	Adhere to company and/or governmental policies, procedures, rules, and regulations					
	Exercise confidentiality					
	Demonstrate appropriate human relations skills					
	Adhere to rules of conduct					
	Accept constructive criticism					
	Offer constructive criticism					
	Take pride in work					
	Resolve conflict					
	Manage stress					
	Avoid sexual connotations and harassment					
	Adjust to changes in the workplace					

: Employability Skills		10	12	AD	O	OJT
	Demonstrate punctuality					
	Assume responsibility for personal decisions and actions					
	Take responsibility for assignments					
Competency:	**Apply decision-making techniques in the workplace**	**I**	**M**	**R**	**O**	
Builders:	Identify decision to be made					
	Identify ownership of decision to be made					
	Identify possible alternatives and their consequences					
	Make decisions based on facts, legality, ethics, goals, and/or corporate culture					
	Apply time factor(s)					
	Present decision to be implemented					
	Evaluate decision made					
	Take responsibility for decision					
Competency:	**Apply problem-solving techniques in the workplace**	**I**	**M**	**R**	**O**	
Builders:	Identify problem					
	Select appropriate problem solving tools/techniques					
	Identify problem causes					
	Identify possible solutions and their consequences					
	Utilize resources to explore possible solutions to problem					
	Contrast advantages and disadvantages of each solution					
	Identify appropriate action					
	Evaluate results					
Competency:	**Exhibit characteristics for job advancement**	**I**	**R**	**R**	**O**	
Builders:	Display positive attitude					

Unit: Employability Skills	**10**	**12**	**AD**	**O**	**OJT**
Demonstrate knowledge of position					
Perform quality work					
Adapt to changing situations and technology					
Demonstrate capability for different positions					
Identify characteristics of effective leaders					
Identify opportunities for leadership in work place/community					
Display creative abilities and initiative to affect change in workplace					
Participate in continuing education/training program					
Explain purpose of supervision, self-discipline and performance evaluation					
Identify appropriate response(s) to criticism from employer, supervisor, or other employees					
Display awareness of corporate culture					
Prepare for job setbacks					

it: Professionalism		**10**	**12**	**AD**	**O**	**OJT**
ompetency:	**Project professional image**	**I**	**M**	**R**	**O**	
Builders:	Define professionalism					
	Exhibit professional appearance					
	Exhibit professional manners					
	Project professional attitude					
	Identify individuals' vital role in organization					
	Exhibit proper etiquette in professionally-related situations					
Competency:	**Achieve individual and professional goals**	**I**	**R**	**R**	**O**	
Builders:	Set flexible, realistic, and measurable goals					
	Identify potential barriers to achieving goals					
	Identify strategies for addressing barriers to goal achievement					
	Breakdown long-term goals into short-term goals					
	Prioritize goals					
	Make commitment to goals					
	Adjust goals					
	Obtain support for goals					
	Reward goals achievement					
Competency:	**Support community well-being**	**I**	**R**	**R**	**O**	
Builders:	Identify environmental, educational, and social issues					
	Participate in social and/or community activities					
Competency:	**Achieve organizational goals**	**I**	**R**	**R**	**O**	
Builders:	Evaluate personal goals in relation to organizational goals					
	Monitor progress by evaluating feedback					

Unit:	**Professionalism**	**10**	**12**	**AD**	**O**	**OJT**
	List responsibilities in relation to organization goals					
	Accomplish assigned tasks					
	Exercise responsibility in relation to organizational goals					
	Set appropriate personal performance standards					
	Communicate goals with supervisor and peers					
	Demonstrate knowledge of products and services					
	Promote organizational image and mission					
Competency:	**Demonstrate positive relations with employers**	**I**	**R**	**R**	**O**	
Builders:	Identify personality types of self and other					
	Identify various management styles					
	Support employer expectations					
	Support employer decisions					
	Accept constructive criticism					
	Give constructive feedback					
	Adapt to changes in work place					
	List factors to consider before resigning					
	Write letter of resignation					
Competency:	**Manage stressful situations**	**R**	**R**	**R**	**O**	
Builders:	Accept stress as part of daily life					
	Identify personal and professional factors contributing to stress					
	Describe physical and emotional responses to stress					
	Evaluate positive and negative effects of stress on productivity					
	Identify strategies for reducing stress					

it: Professionalism		**10**	**12**	**AD**	**O**	**OJT**
	Implement strategies to manage stress					
	Create strategies for developing and maintaining support systems					
Competency:	**Analyze effects of family on work and work on family**	**R**	**R**	**R**		
Builders:	Identify how family values, goals, and priorities are reflected in work place					
	Identify responsibilities and rewards associated with paid and non-paid work					
	Identify responsibilities and rewards associated with families					
	Explain how family responsibilities can conflict with work					
	Explain how work can conflict with family responsibilities					
	Explain how work-related stress can affect families					
	Explain how family-related stress can affect work					
	Identify family support systems and resources					
	Identify work-related support systems and resources					
	Communicate with family regarding work					
Competency:	**Apply lifelong learning skills**	**R**	**R**	**R**		
Builders:	Define lifelong learning					
	Identify factors that cause need for lifelong learning					
	Analyze effects of change					
	Identify reasons why goals change					
	Describe importance of flexibility and adaptability					
	Evaluate need for continuing education/training					
mpetency:	**Manage professional development**	**R**	**R**	**R**	**O**	**OJT**

Unit: Professionalism		**10**	**12**	**AD**	**O**	**OJT**
Builders:	Identify career opportunities					
	Modify career plan					
	Participate in continuing education/training opportunities					
	Document continuing education/training					
	Read profession-related manuals, technical journals, and periodicals					
	Attend meetings, workshops, seminars, conferences, and demonstrations					
	Participate in professional organizations					
	Build personal/professional mentor relationship					
	Build personal/professional support system					
	Build professional network					
	Strengthen communication skills					
	Strengthen leadership skills					
	Strengthen management skills					

[illegible]it: Teamwork		**10**	**12**	**AD**	**O**	**OJT**
Competency:	**Demonstrate knowledge of teamwork**	**M**	**R**	**R**	**O**	
Builders:	Define employee empowerment					
	Differentiate between work groups and teams					
	Identify conditions essential to teamwork					
	Explain influence of company culture on teamwork					
	Identify appropriate situations for using teams					
	Define team structures (e.g.,cross functional, quality improvement, task force, quality circles)					
	Identify team building concepts					
	Describe characteristics and dynamics of teams					
	Identify characteristics of effective team leaders and members					
	Identify responsibilities of a valuable team member					
	Identify methods of involving each member of a team					
	Explain how individuals from various backgrounds contribute to work-related situations (e.g., technical training, cultural heritage)					
	Explain the purpose of facilitators					
	Define consensus					
Competency:	**Demonstrate teamwork**	**M**	**R**	**R**	**O**	**OJT**
Builders:	Identify (mission) purpose of team and intended goal (include time frames)					
	Structure team around purpose					
	Define responsibilities of team members					
	Contribute to efficiency and success of team					
	Work toward individual and team milestones					
	Analyze results of team project					

Unit:	**Teamwork**	**10**	**12**	**AD**	**O**	**OJT**
	Facilitate a team meeting					
	Assist team member(s) with problem					
	Monitor time frame					
Competency:	**Use teamwork to solve problems**	M	R	R	O	OJT
Builders:	Identify appropriate situations for using teams					
	Use problem-solving process in a team setting					
	Identify quality management processes/techniques for resolution/verification					
	Identify quality assurance processes/techniques					
	Prepare presentation					
	Identify appropriate brainstorming methods					
	Identify appropriate graphical tools					
Competency:	**Conduct meetings**	I	R	R	O	OJ
Builders:	Plan agenda					
	Schedule meeting and location					
	Invite appropriate personnel					
	Solicit outside speakers as needed					
	Assign someone to take minutes					
	Make introductions					
	Invite questions and comments and group participation					
	Focus on agenda items					
	Monitor time					
	Close meeting on time					
	Publish minutes in timely manner if appropriate					
	Use project management tools (i.e., gantt chart)					

nit: Computer Literacy		**10**	**12**	**AD**	**O**	**OJT**
Competency:	**Describe personal computer operations**	M	R			
Builders:	Explain how data is stored in main computer memory					
	Explain how computer system executes program instruction					
	Explain computer storage capacity					
	Explain how data is represented					
	Describe data storage techniques					
	Identify types of memory					
Competency:	**Explain information processing cycle**	M	R	O		
Builders:	Define operating systems (e.g., DOS, OS/2, UNIX, WINDOWS)					
	Describe difference between data files and program files					
	Explain PC layout					
Competency:	**Operate computer hardware**	I	M	R	O	
Builders:	Practice proper media handling techniques					
	Identify hardware and its sue					
	Use hardware (e.g., mouse, diskettes, drive, modems, touch screen, printers, digitizers, scanners)					
	Keyboard efficiently					
	Demonstrate basic care of hardware					
Competency:	**Use software**	I	M	R	O	
Builders:	Define software types and functions					
	Describe basic disk operations and care					
	Perform functions necessary to operate software					
	List advantages and disadvantages of integrated and dedicated software					

Unit: Computer Literacy		**10**	**12**	**AD**	**O**	**OJT**
	Demonstrate basic spreadsheet use					
	Demonstrate basic word processing					
	Demonstrate basic database use					
	Demonstrate system commands					
	Demonstrate network use					
Competency:	**Demonstrate proficiency with operating systems**	**M**	**R**	**R**	**O**	
Builders:	Create ASCII text files with a text editor					
	Explain rules for naming files and directories					
	Create directories					
	Remove directories					
	Change directories					
	Copy files					
	Rename files					
	Erase files					
	Format diskettes					
	Label diskettes					
	Explain operating system syntax					
	Use wildcards					
	Operate system software					
	Operate diagnostic software					
	Analyze flow charts					
	Describe computer languages and their uses					

it: Workplace Safety		10	12	AD	O	OJT
Competency:	**Apply general safety precautions**	I	M	R	O	OJT
Builders:	Identify local, state, and federal rules and regulations and why they are needed					
	Identify personal protective wear and equipment					
	Use personal protective wear and equipment					
	Apply workplace safety rules and procedures					
	Apply personal safety rules and procedures					
	Apply workplace organization (e.g., housekeeping)					
	Apply electrical, mechanical, steam, hydraulic and pneumatic safety rules and procedures					
	Apply fire safety rules and procedures					
	Apply hazardous wastes rules and procedures					
	Apply first aid and CPR procedures					
	Describe corrective procedures for unsafe conditions					
	Identify visual controls (e.g., monitors, readouts)					
	Identify auditory controls (e.g., bells, alarms)					
	Perform lockout and tagout					
	Investigate accident (i.e., query why it happened, discuss prevention)					
Competency:	**Demonstrate knowledge of workplace hazards**	I	M	R	O	OJT
Builders:	Identify types of workplace hazards and appropriate personal protection equipment for the hazard (e.g., physical hazards, fire, chemicals, noise, ionizing radiation, ultraviolet, temperature extremes, ergonomics, biological hazards)					
	Interpret hazardous materials notices on containers					
	Locate MSDS					
	Read Material Safety Data Sheets (MSDS)					

Unit: Workplace Safety		10	12	AD	O	OJ
	Explain basic philosophy of right-to-know legislation					
	Explain purpose(s) of OSHA and NIOSH					
	Explain purpose(s) of NEC and NFPA					
	Identify purpose of emergency evacuation routes, master switch and lockout locations, and safety color coding systems					
	Identify roles of industrial hygienists, safety professionals, occupational physicians, and occupational nurses					
	Describe methods of evaluation potential hazards (e.g., visual analysis)					
	Describe methods of correcting potential hazards					
	Describe various types of toxicity (e.g., chronic, immediate)					
	Identify why accidents need to be reported					
	Explain precautions required when using toxic or flammable materials					
	Recycle scrap metal, chips, shavings, coolants, solvents, trash, and waste materials					
	Define confined space and related requirements					
	Identify minimum standards for healthy environment (e.g., levels of noise, fumes, etc.)					
	Explain results of ignoring minimum standards					
Competency:	**Explain purpose of industrial pollution control systems**	M	R	O		
Builders:	Describe types of air, water, solid waste, and noise pollution					
	Explain purpose of air pollution control systems					
	Explain purpose of water pollution control systems					
	Explain purpose of solid waste pollution control systems					
	Explain purpose of noise pollution control systems					
	Explain purpose(s) of EPA					

[illegible]t: Quality Assurance		10	12	AD	O	OJT
Competency:	**Demonstrate knowledge of quality assurance**	I	R	M	O	OJT
Builders:	Explain the historical evolution of quality assurance (e.g., Demming, ISO 9000)					
	Define quality terms					
	Define quality functions					
	Identify features of quality planning					
	Describe control devices used in functional areas (e.g., SPC, equipment)					
	Explain the relationship among organizational structures, policies, procedures, and quality assurance					
	Explain importance of internal and external customers					
	Identify internal and external customers					
	Explain importance of interdepartmental relationships					
	Describe successful efforts by industry to improve quality and/or reduce costs					
	Differentiate prevention and detection					
	Differentiate variable and attribute data					
	Identify types of charts					
	Explain how statistical techniques are tools used to control quality					
Competency:	**Demonstrate knowledge of quality costs and implications**	I	R	M	O	OJT
Builders:	Identify cost/quality objectives					
	Classify costs (i.e., direct and indirect, fixed and variable, methods and standards)					
	Classify quality costs (i.e., prevention, detection, internal failure, external failures)					
	Differentiate between warranty and product liability					

Unit: Quality Assurance		**10**	**12**	**AD**	**O**	**OJT**
	Interpret quality cost reports					
Competency:	**Explain importance of interdepartmental relationships to quality assurance**	**I**	**R**	**AD**	**O**	**OJT**
Builders:	Explain how quality assurance philosophy has changed in recent years					
	Explain need for everyone's commitment in assuring quality					
	Explain phrase "Everyone is a customer/supplier"					
	Define quality improvement team models					
	Explain project selection					
	Explain project implementation					
	Explain project evaluation					
	Explain continuing improvement					
	Describe future trend of experiment design					
	Describe future trend of predictive maintenance					
Competency:	**Examine quality cost data**		**I**	**M**	**O**	**OJT**
Builders:	Develop cost control data					
	Translate cost control reports					
	Graph quality cost data (e.g., pareto)					
Competency:	**Demonstrate knowledge of basic statistics**	**I**	**R**	**M**		
Builders:	Select data collection methods					
	Collect data					
	Organize data by flow chart					
	Interpret data on flow chart					
	Organize data by cause and effect diagrams					
	Interpret data by cause and effect diagrams					

Unit:	**Quality Assurance**	10	12	AD	O	OJT
	Define nominal, ordinal, interval, and ratio data					
	Explain differences of random sampling methods					
	Develop pareto chart					
	Define mean, median, and mode					
	Construct histogram					
	Interpret histogram					
	Compute standard deviation					
	Explain significance of standard deviation					
	Develop run chart					
	Explain normal distribution					
	Define in-control process					
	Explain conditions with non-normal distribution					
Competency:	**Demonstrate knowledge of scattergrams**		I	M		
Builders:	Construct scattergram					
	Interpret for positive, negative, or no correlation between X and Y variables					
	Test for significance between one and five percent					
	Explain regression analysis					
Competency:	**Demonstrate knowledge of probability theory**	I	R	M		
Builders:	Define classical probability					
	Define empirical probability					
	Calculate probability for outcomes					
competency:	**Demonstrate knowledge of process capability**		M			
Builders:	Use X, R, USL, and LSL to determine process capability (upper and lower specification limits)					
	Calculate estimated process standard deviation					

Unit: Quality Assurance		**10**	**12**	**AD**	**O**	**OJT**
	Plot right hand and left hand tail of process variation					
	Compute Z value for percent of probable defect for process					
	Calculate C_{pk} values that describe process capability					
	Describe skewed distributions					
	List probable causes of skewed distribution					
Competency:	**Use attribute control charts**			M		
Builders:	Identify operational definitions for attribute criteria					
	Explain fundamentals of attribute control charts (P, NP, C, U)					
	Interpret P, NP, C, U, control charts					
Competency:	**Interpret X and R charts**		I	M		
Builders:	Plot percentages for normal distribution					
	Test distribution for normality					
	Explain difference between common cause and special cause					
	Explain significance of an out-of-control point on X or R chart					
	Identify patterns and trends on control chart					
	Identify run up and run down					
	Test for middle third on control chart					
	Explain significance of middle third on control chart					
	Explain Rule of Sevens					
Competency:	**Construct X and R charts**		I	M		
Builders:	Arrange data into statistical sub-groups					
	Explain importance of random sampling					

it: Quality Assurance		**10**	**12**	**AD**	**O**	**OJT**
	Compute X (i.e., average of values) and R (i.e., range of values in subgroup) within sample					
	Plot in X and R chart					
	Construct control chart with X (grand average) and R (average range) calculated					
	Calculate upper and lower control limits for X-chart					
	Calculate upper and lower control limits for R-chart					
Competency:	**Conduct process improvement studies**			M		
Builders:	Analyze production methods and processes applying statistical process improvement techniques (e.g., SPC, C_pK)					
	Identify appropriate statistical techniques for study (e.g., T-tests, F-test, capability, DOEX)					
	Identify major steps in conducting a study					
	Define "report" for a study (e.g., goal, objective, study conduct, results, conclusions, discussions)					
	Integrate results into the total system					
Competency:	**Demonstrate knowledge of inspection**	I	R	M	O	OJT
Builders:	Explain purpose of inspection					
	Describe scope of inspection					
	Explain purpose of incoming, ongoing, and final inspections					
	Explain early detection inspection					
	Explain how statistical process control (SPC) aids inspection					
	Define types of nonconformance					
	Define corrective action					
	Describe when to 100% inspect					

Unit: Quality Assurance		**10**	**12**	**AD**	**O**	**OJ**
	Describe when to sample inspect					
	Describe methods of testing for material properties (e.g., harness, strength, chemical makeup, flaws, errors in tooling or setup)					
	Define rework, salvage, and scrap					
	Describe ethical decisions an inspector may make					
	Identify purposes of computer-automated inspection					
	Explain advantages and limitations of automated inspection					
	Explain basic foolproofing concepts to build inspection into process (i.e., poka-yoke)					
	Use checksheets to organize and record inspection results					
Competency:	**Inspect machinery, materials, and products**		**I**	**R**	**O**	**OJT**
Builders:	Identify critical material characteristics from specification(s) or drawing(s)					
	Perform capability studies for machinery and materials acceptance					
	Identify appropriate acceptance sampling plan					
	Conduct incoming materials inspection using sampling plan criteria					
	Identify critical in-process characteristics from specification(s) or drawing(s)					
	Define appropriate inspection reports and follow-up					
	Gauge R and R (reproducibility and repeatability)					
	Use geometric tolerancing					
	Explain C = 0 (zero) acceptance plan					
	Interpret instructions in a control plan					
Competency:	**Demonstrate knowledge of nondestructive testing**			**I**		**OJT**

t: Quality Assurance		10	12	AD	O	OJT
Builders:	Describe purpose of nondestructive testing					
	Identify anomalies					
	Define defects and discontinuities					
	Identify factors contributing to defects and discontinuities					
	Describe ultrasonic testing					
	Describe advantages and limitations of ultrasonic testing					
	Describe industrial radiography					
	Compare use of wet and dry particles in magnetic particle inspection					
	Explain advantages and limitations of penetrant inspection					
	Describe microwave testing					
	Describe holographic inspection					
	Explain choice of most suitable nondestructive test method					
	Describe eddy-current testing					

Unit: Industrial Manufacturing Technology		10	12	AD	O	OJT
Competency:	**Demonstrate knowledge of manufacturing a quality product**	I	R	R		OJT
Builders:	Juxtapose customer satisfaction with product characteristics (e.g., usefulness, price, operation, life, reliability, safety, cost of operation)					
	Define manufacturability					
	Identify steps in product design (e.g., brainstorming, thumbnail sketches, rendering)					
	Define reliability factors (e.g., maintainability, good design, design simplification, design redundancy)					
	Explain the relationship of maintainability to reliability					
	Explain the role of testing and reliability					
	Define value engineering					
	Define quality objectives					
	Identify cost components as they relate to quality objectives					
	Explain predictive maintenance					
	Explain principles and purpose of ISO 9000					
Competency:	**Demonstrate knowledge of JIT**	I	M			
Builders:	Define just-in-time concept (JIT)					
	Describe various production methodologies (e.g., standard cycle times, routings, standard quantities, multiple-machine tending)					
	Describe types of replenishing systems (e.g., Kanban)					
Competency:	**Demonstrate knowledge of materials requirements planning**		I	R		OJT
Builders:	Define materials requirements planning					

it: Industrial Manufacturing Technology		10	12	AD	O	OJT
	Explain importance of maintaining and controlling inventory (e.g., quantity, price, quality, minimal lot sizes, and timeliness)					
	Define master production schedule and bill of materials					
	Explain inventory carrying cost and economic order quantity					
	Describe the use of the computer in MRP					
	Describe relationship of master production schedule and bill of materials					
	Describe outputs from MRP (i.e., material requirements, dates)					
	Calculate net requirements					
	Explain importance of forecast production planning based on historical usage					
	Describe role of purchase requisitions					
	Describe role of material specifications					
	Describe role of quality parameters					
	Define supplier certification rating methods					
	Describe role of source inspector					
	Describe role of receiving					
Competency:	**Demonstrate knowledge of plant layouts and material flow**		I	R		OJT
Builders:	Describe the importance of flexibility					
	Differentiate among product layout, process layout, fixed position layout, and cellular layout					
	Describe the production suited to each layout					
	Describe advantages/disadvantages of each layout and patterns					

Unit: Industrial Manufacturing Technology		10	12	AD	O	OJT
Competency:	**Demonstrate knowledge of methods engineering**			I		OJT
Builders:	Define methods engineering					
	Define goals of methods engineering (i.e., quality, increase productivity, decrease per unit cost)					
	Set sequence of production operations					
	Set sequence of needed inspections					
	Recommend methods to shorten process time					
	Recommend alternate operations					
	Recommend ways to eliminate operations					
	Ascertain if operations can be performed within facilities					
	Test machine capability					
	Follow documentation procedures					
Competency:	**Demonstrate knowledge of standards engineering**			I		OJT
Builders:	Estimate times by computer simulation					
	Use predetermined time system (e.g., MTM family)					
	Define reach, grasp, move position, turn, apply pressure, and release					
	Use work sampling					
	Define standard time					
	Define performance rating					
	List leveling factors (e.g., skill levels, effort, work area conditions, consistency)					
	List allowance factors (e.g., fatigue, delay, personal)					
	Define allowances					
	Calculate production rate					
	Write job description data					

t: Industrial Manufacturing Technology		10	12	AD	O	OJT
	Calculate machine controls to position operator efficiently					
	Physically simulate operation					
	Review total process for simplification					
Competency	**Demonstrate knowledge of ergonomics**	I	R	R		OJT
Builders:	Define ergonomics					
	Define risk factor					
	Define maximum permissible limit (MPL) and action limit (AL) for lifting					
	Define cumulative trauma disorder (CTD)					
	Minimize extreme joint movement					
	Minimize use of excessive muscle force					
	Minimize repetitive tasks					
	Minimize mechanical stress (e.g., sharp edges, heat, cold, hard surfaces, weights, vibration)					
	Minimize awkward body positions					
	Identify need for mats and footrest for standing jobs					
	Identify need for appropriate working heights of chairs, stools, workbenches, equipment					
	Identify need for adequate lighting					
	Explain use of anthropometric design					
	Explain use of rest pauses					
	Identify susceptibility factors for CTD					
	Assure operator does not reach across moving part					
	Eliminate unnecessary body movement					
	Assure safety of operator in accordance with OSHA regulations					

Unit: Industrial Manufacturing Technology		10	12	AD	O	OJT
	Differentiate straight-line, U-shaped, S-shaped, convoluted and comb patterns					
Competency	**Explain quality control of materials handling**		I	R		OJT
Builders:	Explain system for physical handling and movement of material in-process and in-storage					
	Explain system for physical handling and movement of finished products					
	Explain requests for deviation from specifications					
	Write engineering change notices and rejection reports					
	Conduct quality tests under different environmental conditions					
Competency:	**Demonstrate knowledge of post-production control**	I	R	R		OJT
Builders:	Explain importance of product protection, identification and storage					
	List methods of identifying products (e.g., labels, bar codes, radio frequency systems and magnetic strip systems)					
	Describe manual methods of storage and retrieval					
	Describe automated storage and retrieval systems (ASRS)					
	Describe automated guided vehicle moving systems (AGVS)					
	Explain importance of traceability systems					
Competency:	**Demonstrate knowledge of workstation design**			I		OJT
Builders:	Assure minimal movement of materials and parts throughout production line					
	Plan operator's access to materials and tools					
	List type of material handling equipment for operation					
	Calculate bench space needs for process and storage					

[illegible]t: Industrial Manufacturing Technology	10	12	AD	O	OJT
Complete job status reports					
Analyze job evaluation data					

Unit: Technical Recording and Reporting		10	12	AD	O	OJT
Competency:	**Demonstrate proficiency in technical recording**	I	R	M	O	
Builders:	Interpret specifications or drawings					
	Observe process					
	Ask questions					
	Record process (e.g., flowchart, step-by-step)					
	Identify parameters					
	Record data					
	Maintain test logs					
	Compile cumulative reference notebook/record					
	Measure appropriate parameters					
Competency:	**Demonstrate proficiency in technical reporting**	I	R	M	O	
Builder:	Use data books and cross reference/technical manuals					
	Identify type of report needed					
	Compile relevant data					
	Design charts and graphs					
	Analyze data					
	Draw conclusions					
	Outline reports					
	Write reports					
	Present reports					
	Compose technical memoranda					

[illegible]it: Basic Materials Science		10	12	AD	O	OJT
Competency:	**Demonstrate basic knowledge of metal forming**	I	R	M		
Builders:	Define metal forming (e.g., general process)					
	Identify forming industries (e.g., stamping, forging, foundry, die cast, fabricating)					
	Describe metal forming principles					
Competency:	**Demonstrate basic knowledge of metallurgy**	I	R	M		
Builders:	Define metallurgy					
	Describe the metal forming process					
	Describe metal forming principles					
	Identify frequently used metals					
	Describe the crystalline structures of metals					
	Use periodic chart to evaluate metals					
	List chemical properties of common metals					
	List physical properties of common metals					
	Describe measures of metal strength					
	Identify examples of raw materials processed by hot rolling, cold rolling, forging, drawing, extrusion, spinning and powdered metallurgy					
Competency:	**Demonstrate basic knowledge of heat treatment**	I	M			
Builders:	Describe process of heat treating					
	Define annealing					
	Define drawing					
	Define case hardening					
	Define stress relieving					
	Define tempering					
	Define quenching					

Unit: Basic Materials Science		10	12	AD	O	OJT
	Define critical temperature					
	Perform heat treatment					
Competency:	**Demonstrate basic knowledge of mechanical properties testing**	I	M			
Builders:	Explain tensile tests					
	Perform tensile tests					
	Explain hardness test and the various scales					
	Perform hardness tests using the various scales					
	Explain X-ray testing					
	Differentiate destructive vs. non-destructive testing					
Competency:	**Demonstrate basic knowledge of metal characteristics and formability**	I	R	M		
Builders:	Explain metal and formability basics					
	Explain metal grades and coatings					
	Explain part contour analysis					
	Explain metal characteristic tests					
	Explain bend test					
	Explain cup test					
	Explain friction test					
	Explain surface test					
	Explain interpretation of metal characteristics tests					
	Describe blank/die interactions (e.g., friction)					
	Describe friction and forming process					
	Describe circle grid basics					
	Describe circle grid applications					
	Describe formability diagnostics					

[illegible]: **Basic Materials Science**		10	12	AD	O	OJT
	Describe documentation process					
Competency:	**Demonstrate basic knowledge of casting**	I	R	M		
Builders:	Identify frequently used metals					
	Define permanent mold casting					
	Define shell mold casting					
	Define sand casting and pattern making					
	Define die casting					
	Identify basic casting terms					
	Identify advantages/disadvantages of casting processes					
	Define injection molding					
	Define spin mold casting					
Competency:	**Demonstrate basic knowledge of iron and its alloys**	I	M			
[illegible]ders:	Define iron and its alloys					
	Describe iron manufacturing process					
	Describe the structure of iron and its alloys					
	List chemical properties of iron and its alloys					
	List physical properties of iron and its alloys					
	Describe iron and alloys property variables					
	Describe measures of strength for iron and its alloys					
	Identify examples of iron and its alloys processed by hot rolling, stamping, cold rolling, drawing, extrusion, spinning, casting, forging and machining					
	Describe common uses of iron and its alloys					
Competency:	**Demonstrate basic knowledge of aluminum and its alloys**	I	M			
Builders:	Define aluminum and its alloys					

Unit: Basic Materials Science		10	12	AD	O	OJ
	Describe aluminum manufacturing process					
	Describe the structure of aluminum and its alloys					
	List chemical properties of aluminum and its alloys					
	List physical properties of aluminum and its alloys					
	Describe aluminum and alloys property variables					
	Describe measures of strength for aluminum and its alloys					
	Identify examples of aluminum and its alloys processed by hot rolling, stamping, cold rolling, drawing, extrusion, spinning, casting, forging and machining					
	Describe common uses of aluminum and its alloys					
Competency:	**Demonstrate basic knowledge of copper and its alloys (e.g., brass, bronze)**	I	M			
Builders:	Define copper and its alloys					
	Describe copper manufacturing process					
	Describe the structure of copper and its alloys					
	List chemical properties of copper and its alloys					
	List physical properties of copper and its alloys					
	Describe copper and alloys property variables					
	Describe measures of strength for copper and its alloys					
	Identify examples of copper and its alloys processed by hot rolling, stamping, cold rolling, drawing, extrusion, spinning, casting, forging and machining					
	Describe common uses of copper and its alloys					
Competency:	**Demonstrate basic knowledge of plastics and polymers**	I	M			
Builders:	Define plastics and polymers					
	Describe plastics and polymers manufacturing processes					

[illegible]t: Basic Materials Science		**10**	**12**	**AD**	**O**	**OJT**
	Describe structure of plastics and polymers					
	List chemical properties of plastics and polymers					
	List physical properties of plastics and polymers					
	Differentiate thermoset and thermoplastic					
	Describe plastic and polymer property variables					
	Describe measure of plastic and polymer strength					
	Identify examples of raw materials processed by machining, extrusion, stamping, injection molding, compression molding and injection compression molding					
	Perform R-value test					
	Identify molding defect (e.g., flash, sink marks, warp, contamination, wet material, stuck parts, short shot, burn marks, surface blemishes)					
	Identify secondary operations performed on plastic parts					
Competency:	**Demonstrate basic knowledge of concrete**	I	M			
Builders:	Describe the formation of concrete					
	List types of cements and their uses					
	Define qualities of concrete (i.e., strength, consistency, homogeneity, tensile force, abrasion, heat of hydration, and heat and sulfate resistance)					
	List tests used in concrete production (e.g., slump test, test of fineness modules)					
	List protective practices used after pouring					
Competency:	**Demonstrate basic knowledge of ceramics**	I	M			
Builders:	List ingredients of ceramic products					
	List qualities of ceramic products					

Unit: Basic Materials Science		10	12	AD	O	OJT
	Describe quality control tests (e.g., compressive strength test, wear resistance test, temperature resistance test)					
	List use of ceramics					
Competency:	**Demonstrate knowledge of corrosion and protection**	M				
Builders:	Identify causes of corrosion					
	Identify types of corrosion					
	List solutions to minimize problems					
Competency:	**Demonstrate basic knowledge of rubber manufacturing**	I	M			
Builders:	Explain history of rubber industry					
	Compare properties of natural rubber with those of synthetic rubber					
	Explain how natural rubber is manufactured					
	Explain vulcanization, mastication, and cure systems					
	Explain use of compounding ingredients (e.g., carbon blacks, accelerators, fillers, antioxidants)					
	Explain press and autoclave curing					
	Explain how synthetic rubber is manufactured (e.g., neoprene, butyl, styrene-butadiene)					

it: Welding		10	12	AD	O	OJT
Competency:	**Perform gas welding, brazing, and cutting**	I	M	R		
Builders:	Follow safety guidelines					
	Differentiate welding and brazing					
	Identify gas welding and cutting equipment and accessories					
	Use personal protective equipment required for welding and cutting					
	Explain capillary attraction as it applies to metal					
	Demonstrate proper lighting, adjusting, and shutting down of gas torch					
	Layout mild steel					
	Cut mild steel					
	Braze mild steel					
	Solder non-ferrous metals					
	Apply basic metallurgy technology					
	Explain process of silver solder					
Competency:	**Perform arc welding/cutting**	I	M	R		
Builders:	Identify arc welding equipment and accessories					
	Explain process of resistance welding					
	Explain process of projection welding					
	Explain process of flash-butt welding					
	Explain process of laser welding					
	Explain process of friction welding					
	Explain process of spot welding					
	Explain process of shielded metal-arc welding (SMAW)					
	Explain process of gas metal-arc welding (GMAW)					

Unit: Welding	10	12	AD	O	OJT
Explain process of gas tungsten-arc welding (GTAW)					
Explain process of plasma-arc cutting					
Explain process of carbon arc gouging and cutting					
Explain process of welding plastics					
Explain welding rod alloys					
Read welding rods					
Demonstrate use of mild steel welding rod					
Demonstrate use of low hydrogen welding electrode					
Weld stainless steel using (SMAW) process					
Explain rationale for preheating and post-heating metal					
Weld steel requiring preheat					
Weld cast iron					
Weld aluminum					
Apply basic metallurgy technology					
Demonstrate (GMAW) welding in flat, horizontal, vertical positions					
Demonstrate (GTAW) welding on mild steel, stainless steel, and aluminum,					
Demonstrate process of build up and hard facing					
Troubleshoot fusion of materials					

t: Industrial Electricity		10	12	AD	O	OJT
Competency:	**Demonstrate proficiency in basic theory**	I	R	M		
Builders:	Describe atomic structure and its relationship to electricity					
	Describe the relationship between electrical and magnetic properties					
	Describe the electrical and magnetic properties of a magnet					
	Describe the photoelectric effect					
	Describe the thermocouple effect					
	Describe the electrical effect of friction					
	Identify sources of electricity					
	Explain Ohm's law					
Competency:	**Demonstrate use of National Electrical Code (NEC)**	I	R	R	O	
ders:	Use NEC to identify correct materials					
	Use NEC to identify correct methods					
	Use NEC to identify correct applications					
	Use NEC to identify correct safety procedures					
Competency:	**Explain operation of electrical distribution systems**	I	R	R	O	
Builders:	Explain operation of electric system (e.g., flow chart-sub-station-transformer-power factor correction-plant distribution-surge protection-buss system)					
	Follow NEC, NFPA, local, state, and national codes					
	Describe functions of permits and licensing requirements					
Competency:	**Maintain basic electrical systems**	I	M			
Builders:	Replace electrical cords					
	Replace batteries					

Unit: Industrial Electricity		**10**	**12**	**AD**	**O**	**OJT**
	Replace fuse(s)					
	Replace switches					
	Replace plugs and sockets					
	Define lighting requirements					
	Replace lighting system (e.g., ballasts)					
Competency:	**Interpret electrical/electronic drawings**	I	R	M		
Builders:	Interpret basic electric/electronic standards and symbols					
	Interpret schematic drawings					
	Interpret cable drawings					
	Interpret component drawings					
	Interpret logic diagrams					
	Interpret control panel drawings					
	Interpret connection drawings (e.g., power source to device)					
	Interpret interconnection drawings (e.g., device to device)					
	Interpret printed circuit board drawings					
	Interpret harness drawings					
	Interpret package drawings					
	Interpret mechanical/electronic production blueprints and assembly drawings					
Competency:	**Prepare electrical drawings**	I	R	M		
Builders:	Modify drawings (e.g., update prints)					
	Modify installation drawings to the specific need					
	Sketch basic wiring schematics					
Competency:	**Demonstrate proficiency in direct current (DC) circuits**	I	R	M		

it: Industrial Electricity		10	12	AD	O	OJT
Builders:	Describe voltage, current, resistance, power, and energy					
	Solve algebraic problems to include exponential (prerequisite to DC)					
	Measure properties of a circuit using volt-ohm meter (VOM) and digital volt-ohmn meter (DVM) meters and oscilloscopes					
	Construct operations of series circuits					
	Apply Ohm's law					
	Construct parallel circuits					
	Construct series circuits					
	Construct series parallel and bridge circuits					
	Define voltage divider circuits (loaded and unloaded)					
	Construct DC circuits that demonstrate the maximum power transfer theory					
	Solve problems in electrical units utilizing metric prefixes					
	Describe the principles and operation of electrochemical supplies					
	Use Watt's law					
	Use Kirchoff's law					
	Interpret color codes and symbols to identify electrical components and values					
	Measure properties of a circuit using analog and digital meters and oscilloscopes					
	Measure conductance and resistance of conductors and insulators					
	Describe magnetic properties of circuits and devices					

Unit: Industrial Electricity		**10**	**12**	**AD**	**O**	**OJT**
	Describe the physical and electrical characteristics of capacitors and inductors					
	Describe RC and RL time constants and classify the output of differentiators and integrators					
	Set up power supplies for DC circuits					
	Operate power supplies for DC circuits					
	Analyze frequency spectrums					
	Use Thevenin's and Norton's theorems					
Competency	**Demonstrate proficiency in alternating current (AC) circuits**	I	R	M		
Builders:	Solve basic trigonometric problems as applicable to electricity (prerequisite to AC)					
	Analyze AC signals utilizing VOM, DVM, oscilloscope, frequency counter and function generator					
	Analyze power in AC circuits					
	Measure power in AC circuits					
	Set up capacitor and inductor analyzers for AC circuits					
	Operate capacitor and inductor analyzers for AC circuits					
	Analyze properties of an AC signal					
	Describe the principles and operation of the characteristics of sinusoidal and non-sinusoidal wave forms					
	Identify AC sources					
	Describe the principles and operation of the characteristics of capacitive circuits					
	Demonstrate the operation of capacitive circuits					
	Describe the principles and operation of the characteristics of inductive circuits					

it: Industrial Electricity	10	12	AD	O	OJT
Demonstrate the operation of inductive circuits					
Describe the principles and operation of the principles of transformers					
Describe function of emergency interrupt circuits					
Demonstrate the operation of AC circuits utilizing transformers					
Operate differentiators and integrators to determine RC and RL time constants					
Describe the principles and operation of the characteristics of RLC circuits (series, parallel, and complex)					
Demonstrate the operation of RLC circuits (series, parallel, and complex)					
Describe the principles and operation of the characteristics of series and parallel resonant circuits					
Operate series and parallel resonant circuits					
Describe the principles and operation of the characteristics of frequency selective filter circuits					
Demonstrate the operation of frequency selective filter circuits					
Operate polyphase circuits					
Describe basic motor theory and operation					
Describe basic generator theory and operation					
Operate power supplies for AC circuits					
Describe the principles and operation of various power conditioning (e.g., isolation transformers, surge suppressors, uninterruptable power systems)					
Describe the principles and operation of various safety grounding systems (e.g., lightning arresters, ground fault interrupters, etc.)					

Unit: Industrial Electricity	10	12	AD	O	OJT
Use maximum power transfer theorems					
Use Thevenin's and Norton's theorems to analyze AC networks					

Unit: Basic Electronics		**10**	**12**	**AD**	**O**	**OJT**
Competency:	**Demonstrate proficiency in electronics fundamentals**	**I**	**R**	**M**		
Builders:	Identify electronic components and schematic symbols					
	Describe basic atomic structure and its relationship to electricity					
	Describe the relationship between electrical and magnetic properties					
	Describe the electrical and magnetic properties of a magnet					
	Describe the photoelectric effect					
	Describe the thermocouple effect					
	Describe the electrical effect of friction					
	Use *metric* prefixes to solve electronic unit problems					
	Identify sources of electricity					
	Describe principles and operations of electrochemical supplies					
	Describe voltage, current, resistance, power, and energy					
	Apply Ohm's laws					
	Apply Kirchoff's law					
	Apply Watt's law					
	Explain Thevenin's theorem					
	Explain Norton's theorem					
	Apply power formulas					
	Interpret color codes and symbols to identify electrical components and values					
	Measure properties of circuits using test equipment					
	Describe electrostatic discharge (ESD) procedures					

Unit: Basic Electronics		10	12	AD	O	OJT
Competency:	**Demonstrate proficiency in DC circuits**			M		
Builders:	Compute conductance of conductors and insulators					
	Measure resistance and current of conductors and insulators					
	Measure properties of a circuit using volt-ohm meter (VOM) and digital volt-ohm meter (DVM)					
	Build series, parallel, and combination circuits					
	Build bridge circuits					
	Build voltage divider circuits (loaded and unloaded)					
	Compute voltage divider circuits (loaded and unloaded)					
	Demonstrate maximum power transfer theory					
	Describe magnetic properties of circuits and devices					
	Explain physical and electrical characteristics of capacitors and inductors					
	Describe RC and RL time constants					
	Compute RC and RL time constants					
	Demonstrate use of diodes in DC circuits					
	Identify need for rectification					
	Operate power supplies for DC circuits					
	Analyze frequency spectrums					
	Construct the operation of DC circuits that demonstrate the maximum power transfer theory					
	Use meters and oscilloscopes					
	Measure current, voltage, and resistance in DC circuits					
	Explain simple DC generator action					
	Explain simple DC motor action					
	Explain principals of solid-state switching devices					

	: Basic Electronics	10	12	AD	O	OJT
	Solve algebraic problems to include exponential (prerequisite to DC)					
	Explain use of and durability DC in relation to communications					
	Identify classes, voltage ratings and/or polarity of electronic components					
	Identify use of circuit protective devices (e.g., fuses, breakers)					
	Troubleshoot DC circuits					
Competency:	**Demonstrate proficiency in AC circuits**			M		
Builders:	Analyze properties of an AC signal					
	Describe principles and operation of characteristics of sinusoidal and non-sinusoidal wave forms					
	Identify AC sources					
	Describe principles and operation of characteristics of capacitive circuits					
	Operate capacitive circuits					
	Describe principles and operation of characteristics of inductive circuits					
	Operate inductive circuits					
	Describe principles and operation of transformers					
	Demonstrate operation of AC circuits utilizing transformers					
	Use maximum power transfer theorems					
	Use Thevenin's and Norton's theorem to analyze AC circuits					
	Measure power in AC circuits					
	Operate capacitor and inductor analyzers for AC circuits					

Unit: Basic Electronics	10	12	AD	O	OJT
Operate differentiators and integrators to determine RC and RL time constants					
Describe principles and operation of characteristics of series and parallel resonant circuits					
Build series and parallel resonant circuits					
Identify classes, voltage, ratings and/or polarity of electronic components					
Identify use of circuit protective devices (e.g., fuses, breakers)					
Describe principles and operation of characteristics of frequency selective filter circuits					
Calculate logarithmic to obtain gain (dB)					
Operate frequency selective filter circuits					
Operate polyphase circuits					
Describe basic motor theory and operation					
Describe basic generator theory and operation					
Operate power supplies for AC circuits					
Describe principles and operation of various power conditioning (e.g., isolation transformers, surge suppressors, uninterruptable power systems)					
Describe principles and operation of various safety grounding systems (e.g., lightning arresters, ground electrostatic discharge, fault interrupters, etc.)					
Describe characteristics of inductors in series and parallel circuits					
Describe characteristics of capacitance in series and parallel circuits					
Compare resistive-capacitive (RC) and resistive-inductive(RL) time constants (TC)					

t: Basic Electronics	10	12	AD	O	OJT
Measure voltage, current, time, frequency (F), and phase relationships of AC sine wave signal					
Describe frequency (F) and phase relationships					
Describe resonance of inductive-capacitive (LC) circuits					
Calculate impedance match and maximum transfer of power					
Measure current, voltage, and resistance in AC circuits					
Identify various frequencies (e.g., 50/60 Hertz)					
Explain simple AC generator action					
Explain simple AC motor action					
Explain how to calculate power factor in AC circuits					
Calculate power factor in AC circuits					
Explain harmonics and its effects on power quality					
Solve basic trigonometric problems as applicable to electronics					
Calculate peak (PK), root mean square (RMS), and average values					
Troubleshoot AC circuits					

Unit: Fundamentals of Electronics Technology		**10**	**12**	**AD**	**O**	**OJT**
Competency:	**Demonstrate proficiency in discrete solid-state devices**		I	M		
Builders:	Describe properties of semiconductor materials					
	Describe operating characteristics and applications of PN junctions					
	Demonstrate operation of diode circuits					
	Troubleshoot diode circuits					
	Replace diode circuits					
	Describe operating characteristics and applications of bipolar transistors					
	Describe operating characteristics and applications of field effect transistors (e.g., FET + s/MOSFET + s)					
	Describe operating characteristics and application of special diodes//transistors					
	Describe operating characteristics and applications of opto-electronic devices (e.g., gate isolators, interrupt sensors, infra red sensors)					
	Describe operating characteristics and applications of single-stage amplifiers					
	Demonstrate the operation of the single-stage amplifiers					
	Troubleshoot single-stage amplifiers					
	Repair single-stage amplifiers					
	Demonstrate the operation of thyristor circuitry (SCR, TRIAC, DIAC, etc.)					
	Troubleshoot thyristor circuitry (SCR<, TRIAC, DIAC, etc.)					
	Operate analog and digital equipment for solid-state devices					
	Operate power supplies for solid-state devices					

: Fundamentals of Electronics Technology		**10**	**12**	**AD**	**O**	**OJT**
	Operate oscilloscopes for solid-state devices					
	Operate function generators for solid-state devices					
	Operate curve tracers					
	Operate transistor testers					
Competency:	**Demonstrate proficiency in analog circuits**		I	M	O	
Builders:	Operate measuring instruments for analog circuits					
	Describe operational characteristics and applications of multistage amplifiers					
	Demonstrate the operation of multistage amplifiers					
	Troubleshoot multistage amplifiers					
	Repair or replace multistage amplifiers					
	Describe operating characteristics and applications of linear integrated circuits					
	Describe operating characteristics and applications of power supplier and filters					
	Demonstrate the operation of power supplies and filters					
	Troubleshoot power supplies and filters					
	Repair or replace power supplies and filters					
	Describe operating characteristics and applications of operational amplifier circuits					
	Demonstrate the operation of operational amplifier circuits					
	Troubleshoot operational amplifier circuits					
	Describe the operating characteristics of audio power amplifiers					
	Demonstrate the operation of audio power amplifiers					
	Troubleshoot audio power amplifiers					

Unit: Fundamentals of Electronics Technology		10	12	AD	O	OJT
	Repair audio power amplifiers					
	Describe the operating characteristics and applications of regulated and switching power supply circuits					
	Demonstrate the operation of regulated power supply circuits					
	Troubleshoot regulated and switching power supply circuits					
	Repair or replace regulated and switching power supply circuits					
	Describe operating characteristics and applications of active filters					
	Demonstrate the operation of active filter circuits					
	Troubleshoot active filter circuits					
	Repair or replace active filter circuits					
	Describe operating characteristics and applications of sinusoidal and non-sinusoidal oscillator circuits					
	Demonstrate the operation of oscillator circuits					
	Troubleshoot oscillator circuits					
	Repair or replace oscillator circuits					
	Describe the operating characteristics and applications of motor phase-shift control circuits (single-phase and multi-phase)					
	Describe the operating characteristics and applications of cathode ray tubes					
	Describe operation of a wheatstone bridge					
Competency:	**Demonstrate proficiency in digital circuits**		I	M		
Builders:	Operate logic problems for digital circuits					
	Operate power supplies for digital circuits					
	Troubleshoot power distribution and noise problems					

t: Fundamentals of Electronics Technology	10	12	AD	O	OJT
Repair or replace power distribution and noise problems					
Operate pulsers for digital circuits					
Operate oscilloscopes for digital circuits					
Describe characteristics of integrated circuit (IC) logic families					
Describe the principles and operation of types of logic gates and their truth tables					
Demonstrate the use of logic gates					
Troubleshoot logic gates					
Repair or replace logic gates					
Describe the principles and operation of combinational logic circuits					
Demonstrate the operation of combinational logic circuits					
Troubleshoot combinational logic circuits					
Repair or replace combinational logic circuits					
Describe the principles and operation of numbering systems, codes, and arithmetic operations					
Minimize logic circuits using Boolean operations					
Describe the principles and operation of types of flip-flops					
Demonstrate the operation of flip-flops					
Troubleshoot flip-flops					
Repair or replace flip-flops					
Describe the principles and operation of types of registers and counters					
Demonstrate the operation of registers and counters					
Troubleshoot registers and counters					

Unit: Fundamentals of Electronics Technology		10	12	AD	O	OJT
	Repair or replace registers and counters					
	Describe the principles and operation of clock and timing circuits					
	Demonstrate the operation of clock and timing circuits					
	Troubleshoot clock and timing circuits					
	Repair or replace clock and timing circuits					
	Describe the principles and operation of types of arithmetic-logic circuits					
	Demonstrate the operation of arithmetic-logic circuits					
	Troubleshoot arithmetic-log circuits					
	Repair or replace arithmetic-log circuits					
	Describe the principles and operation of types of encoders and decoders					
	Demonstrate the operation of encoders and decoders					
	Troubleshoot encoders and decoders					
	Repair or replace encoders and decoders					
	Describe the principles and operation of types of multiplexer and demultiplexer circuits					
	Demonstrate the operation of multiplexer and demultiplexer circuits					
	Troubleshoot multiplexer and demultiplexer circuits					
	Repair or replace multiplexer and demultiplexer circuits					
	Describe the principles and operation of digital-to-analog and analog-to-digital circuits					
Competency:	**Demonstrate proficiency in digital and analog circuits**		I	M	O	
Builders:	Demonstrate the operation of digital-to-analog and analog-to-digital circuits					

[illegible]t: Fundamentals of Electronics Technology		**10**	**12**	**AD**	**O**	**OJT**
	Troubleshoot digital-to-analog and analog-to-digital circuits					
	Repair or replace digital-to-analog and analog-to-digital circuits					
	Describe the principles and operation of types of digital display circuits					
	Demonstrate the operation of digital display circuits					
	Troubleshoot digital display circuits					
	Repair or replace digital display circuits					
	Describe the types of digital display devices					
	Demonstrate the operation of digital display devices					
	Troubleshoot digital display devices					
	Replace digital display devices					
	Describe the operating characteristics and applications of fiber optics					
	Demonstrate the operation of fiber optics					
	Troubleshoot fiber optics					
	Replace fiber optics					
Competency:	**Demonstrate proficiency in microprocessors**		I	M	O	
Builders:	Describe the essential components of a microprocessor and their functions					
	Identify the levels of computer languages					
	Operate oscilloscopes and logic/data analyzers					
	Describe the principles and operation of BUS concepts					
	Describe the principles and operation of types of memory circuits					
	Demonstrate the operation of memory circuits					

Unit: Fundamentals of Electronics Technology		10	12	AD	O	OJT
	Troubleshoot memory circuits					
	Repair or replace memory circuits					
	Describe microprocessor instruction sets					
	Describe the principles and operation of microprocessor machine code					
	Demonstrate the use of microprocessor machine code					
	Troubleshoot (debug) microprocessor machine code					
	Describe types of peripherals					
	Demonstrate ability to interface peripherals					
Competency:	**Demonstrate knowledge of manufacturing electronic devices and micromechanisms**			AD		OJT
Builders:	List properties of electronic packaging materials					
	Describe manufacturing of electronic products chips; integrated circuits; printed integrated circuits					
	Describe joining and assembly of electronic components					
	Describe coating and etching processes					
	List principles of packaging electronic components					
	Describe manufacture of miniature devices					
	Describe testing of joints					
	Describe reliability of electronic product testing					
	Describe the advantages and disadvantages of various advanced packaging techniques (e.g., SMD, MCM)					
	Describe methods of fabrication					
	Describe appropriate troubleshooting/rework techniques					

it: Troubleshooting and Repair		10	12	AD	O	OJT
Competency:	**Demonstrate troubleshooting techniques**	I	R	M	O	
Builders:	Explain concept of preventive maintenance					
	Explain troubleshooting procedures					
	Explain logical support actions taken to troubleshoot					
	Identify troubleshooting aids					
	Demonstrate knowledge of safety rules for troubleshooting and repair procedures					
	Maintain troubleshooting and repair records					
	Interpret prints (e.g., PID, loopsheets)					
	Use manufacturer's manuals, schematics, and troubleshooting charts					
Competency:	**Apply troubleshooting techniques to DC circuits**	I	R	M	O	
ders:	Isolate faults in series, parallel and series parallel					
	Isolate faults in bridge circuits					
	Isolate faults in DC power supplies					
	Perform polarity check					
	Isolate faults to DC drive system					
	Isolate faults in voltage divider circuits (loaded and unloaded)					
	Isolate faults in solar power system					
Competency:	**Apply troubleshooting techniques to AC circuits**	I	R	M	O	
Builders:	Isolate faults in capacitive circuits					
	Isolate faults in inductive circuits					
	Isolate faults in AC circuits utilizing transformers (e.g., step up and step down)					
	Isolate faults in differentiator and integrator circuits					
	Isolate faults in RC, RL, RLC circuits					

Unit: Troubleshooting and Repair		10	12	AD	O	OJT
	Isolate faults in frequency selective filter circuits					
	Isolate faults to AC frequency drive systems					
competency:	**Apply troubleshooting techniques in discrete solid-state devices**	I	R	M	O	
Builders:	Isolate faults in diode circuits					
	Isolate faults in thyristor circuitry (e.g., SCR, TRIAC, DIAC)					
	Isolate faults in transistor circuits					
	Isolate faults in operational amplifier circuits					
	Isolate faults in single-stage amplifiers					
	Isolate faults in open circuits					
Competency:	**Apply troubleshooting techniques to analog circuits**	I	R	M	O	
Builders:	Isolate faults in single and multistage amplifiers					
	Isolate faults in audio power amplifiers					
	Isolate faults in regulated and switching power supply circuits					
	Isolate faults in active filter circuits					
	Isolate faults in oscillator circuits					
	Isolate faults in operational amplifier circuits					
	Isolate faults in power supplies (loaded and unloaded) and filters					
Competency:	**Apply troubleshooting techniques to digital circuits**	I	R	M	O	
Builders:	Identify power distribution and noise problems					
	Isolate faults in combinational logic circuits					
	Isolate faults in multiplexer and demultiplexer circuits					
	Isolate faults in digital display circuits					
	Isolate faults in logic gates					

it: Troubleshooting and Repair		10	12	AD	O	OJT
	Isolate faults in flip-flops					
	Isolate faults in registers and counters					
	Isolate faults in clock and timing circuits					
	Isolate faults in arithmetic-log circuits					
	Isolate faults in encoders and decoders					
	Isolate faults in digital-display devices					
Competency:	**Apply troubleshooting techniques to a microcomputer system**	I	R	M	O	
Builders:	Isolate faults in systems boards					
	Isolate faults in memory circuits					
	Isolate faults in data storage devices					
	Isolate faults in power supplies					
	Debug microprocessor machine code					
	Troubleshoot I/O ports					
	Isolate faults in I/O interface circuitry					
	Use diagnostic software					
Competency:	**Apply troubleshooting techniques to manufacturing systems**	I	R	M	O	
Builders:	Identify individual process blocks of assembly line or process					
	Identify process block interfaces					
	Isolate system faults to process block					
	Isolate block faults using schematics					
	Isolate block faults using programmable controller indicators					
	Isolate block faults using test equipment					

Unit: Troubleshooting and Repair	10	12	AD	O	OJT
Repair block faults by replacing fault component or wiring					
Demonstrate steps required for efficient systems troubleshooting					

it: Electrical and Electronic Test and Measurement Equipment		**10**	**12**	**AD**	**O**	**OJT**
Competency:	**Demonstrate proficiency in use of test equipment**	**I**	**R**	**R**		**OJT**
Builders:	Describe function and operation of logic probe and logic analyzer					
	Describe function and operation of power monitor					
	Describe function and operation of power factor equipment					
	Describe function and operation of signal generator					
	Describe function and operation of spectrum analyzer					
	Describe function and operation of AC/DC hi-pot					
	Describe function and operation of time-domain reflectometer (TDR)					
	Describe function and operation of megger					
	Describe function and operation of curve tracer/analogger					
	Apply test equipment to DC circuits					
	Apply test equipment to AC circuits					
	Apply test equipment to solid-state devices					
	Apply test equipment to digital circuits					
	Apply test equipment to analog circuits					
	Apply test equipment to microprocessors					
Competency:	**Demonstrate proficiency in use of measurement equipment**	**I**	**R**	**R**		**OJT**
Builders:	Describe function and operation of analog volt-ohm meter (AVOM)					
	Describe function and operation of digital volt-ohm meter (DVOM)					
	Describe function and operation of amp probe					

Unit: Electrical and Electronic Test and Measurement Equipment	**10**	**12**	**AD**	**O**	**OJT**
Describe function and operation of oscilloscopes					
Describe function and operation of operation of infrared heat sensor					
Apply measurement equipment to DC circuits					
Apply measurement equipment to AC circuits					
Apply measurement equipment to solid-state devices					
Apply measurement equipment to digital circuits					
Apply measurement equipment to analog circuits					
Apply measurement equipment to microprocessors					

nit: Equipment Installation		**10**	**12**	**AD**	**O**	**OJT**
Competency:	**Demonstrate knowledge of installation procedures**					**OJT**
Builders:	Explain relocation procedures for new equipment in an existing facility					
	Explain the use of anchors and isolators					
	Explain procedures for moving and installing new equipment					
	Explain leveling and aligning procedures					
	Explain test run guidelines					
	Explain safety precautions for equipment installation procedures					
	Explain grouting procedures					
	Explain installation of utilities (e.g., electricity, air, water, drains)					
npetency:	**Prepare for equipment installation**					**OJT**
Builders:	Identify equipment requirements (including safety)					
	Identify maintenance services					
	Identify method of moving equipment					
	Identify symbols					
	Read drawings and schematics					
	Revise drawings					
	Interpret blueprints					
	Identify operators' needs for operation					
Competency:	**Install equipment**					**OJT**
builders:	Prepare site					
	Use measuring devices					
	Calculate weight					
	Follow manufacturer's specifications					

Unit: Equipment Installation		**10**	**12**	**AD**	**O**	**OJT**
	Use appropriate moving equipment					
	Align equipment to layout specifications					
	Identify benchmark locations					
	Apply electrical, mechanical, hydraulic, and/or pneumatic principles					
Competency:	**Perform rigging functions**					OJT
Builders:	Estimate the weight of a load					
	Find the center of gravity					
	Identify the rigging and slings used in maintenance work					
	Explain safety inspection procedures for rigging, ropes, and slings					
	Perform safety inspection procedures for rigging, ropes, and slings					
	Identify rope fiber types					
	Tie rigging knots, bends, and hitches					
	Identify types of wire rope					
	Cut wire rope					
	Seize wire rope					
	Install wire rope eyes, sockets, hooks, and chains					
	Identify cranes and hoists					
	Splice wire rope					
	Erect a scaffold					
	Rig life belts and nets					
	Identify the weight capacity of rigging or sling device					

nit: Equipment Maintenance		**10**	**12**	**AD**	**O**	**OJT**
Competency:	**Perform housekeeping**	**I**	**M**	**R**		
Builders:	Dispose of scrap metal chips, shavings, trash and waste					
	Clean work area					
	Store hand tools, cutters, fixtures, jigs and attachments					
	Follow tool crib procedures (e.g., return tools)					
	Inspect machine guards					
	Replace or adjust machine guards					
	Report problems to supervisor					
	Respect personal property					
Competency:	**Perform recordkeeping**	**I**	**M**	**R**		
Builders:	Complete work order					
	Complete internal requisition					
	Complete external requisition					
	Complete time cards					
	Complete job status reports					
	Complete equipment failure reports					
	Record preventive maintenance activities					
	Record repair activities					
	Read job orders and process sheets					
	Locate tooling and set up information					
	File reports					
	Analyze system failure					
	Make minor adjustment/repairs					
	Coordinate maintenance services					
	Prepare new/replacement equipment recommendations					

Unit: Equipment Maintenance		10	12	AD	O	OJT
Competency:	**Inspect machine systems**	I	M			
Builders:	Explain need for planned maintenance					
	Explain need for predictive maintenance measures					
	Explain need for preventive maintenance measures (e.g., lubrication)					
	Explain machine system(s) calibration					
	Inspect linkages and lever mechanisms					
	Inspect drive couplings					
	Inspect clutches					
	Inspect roller ball bearings					
	Inspect safety systems					
	Prepare planned maintenance schedules					
	Explain breakdown maintenance					
	Explain reasons for keeping maintenance records					
	Explain reasons for keeping cost records					
	Explain need for logging machine histories					
Competency:	**Perform machine maintenance**	I	M			
Builders:	Maintain accurate library					
	Use operator's and manufacturer's manuals					
	Operate individual machines					
	Diagnose malfunctions					
	Use lockout/tagout procedure					
	Disassemble defective section					
	Clean equipment					
	Repair or replace defective parts					

: Equipment Maintenance		10	12	AD	O	OJT
	Test machine for performance					
	Make minor adjustments to equipment					
	Interface with operator					
Competency:	**Maintain hand tools**	I	M			
Builders:	Demonstrate use and care of measuring devices (e.g., rules, tapes, calipers, micrometers, multimeter, thermometer, and coordinate measuring system)					
	Demonstrate use and care of equipment used to bend and assemble rigid conduit and tubing					
	Demonstrate use and care of common hand tools					
	Demonstrate use and care of wood working tools (e.g., saws, planes, drills, hammers)					
	Demonstrate use and care of sheet metal tools (e.g., sheet metal gauges, hand seamers, soldering irons)					
	Demonstrate use and care of ropes, slings, pullers, and block and tackle					
	Demonstrate proper metal working bench skills (including use of vices, hacksaws, files, taps, dies, and reamers)					
Competency:	**Maintain portable power tools**					
Builders:	Demonstrate use and care of light-duty and heavy duty drills					
	Demonstrate use and care of electric hammers					
	Demonstrate use and care of pneumatic drills and hammers					
	Demonstrate use and care of power screwdrivers and impact wrenches					
	Demonstrate use and care of linear motion saws					
	Demonstrate use and care of circular saws					

Unit: Equipment Maintenance		10	12	AD	O	OJT
	Demonstrate use and care of routers and planes					
	Demonstrate use and care of belt, pad and disc sanders					
	Demonstrate use and care of grinders and shears					
	Demonstrate use and care of explosive actuated tools					
	Demonstrate use and care of electric lifts					
	Demonstrate use and care of threaders, benders, and cut-off saw					
	Demonstrate use and care of hydraulic hose press					
Competency:	**Maintain stationary equipment**		M			OJT
Builders:	Demonstrate use and care of mechanical presses					
	Demonstrate use and care of hydraulic presses					
	Demonstrate use and care of drill presses					
	Demonstrate use and care of bench grinders					
	Demonstrate use and care of power saws (e.g., hack, cut-off, chop, band, jig, and table)					
	Demonstrate use and care of band saws					
	Demonstrate use and care of metal brakes					
	Demonstrate use and care of power shears					

t: Wiring Methods		10	12	AD	O	OJT
Competency:	**Demonstrate use of National Electrical Code (NEC) and national Fire Protection Act (NFPA)**	**I**	**M**	**R**		
Builders:	Use NEC and NFPA to identify correct materials					
	Use NEC and NFPA to identify correct methods					
	Use NEC and NFPA to identify correct applications					
	Use NEC and NFPA to identify correct safety procedures					
Competency:	**Explain circuit protectors**	**I**	**M**	**R**		
Builders:	Explain grounding/bonding methods					
	Explain ground-fault circuit interrupters					
	Explain overcurrent protection					
	Explain thermal protective devices					
mpetency:	**Install wiring**	**I**	**M**			
ilders:	Describe functions of permits and licensing requirements					
	Interpret blueprints					
	Verify on-site dimensions					
	Install electrical boxes and panels					
	Describe overhead and underground service					
	Calculate load size conductors					
	Identify proper color coding					
	Lay out conduit runs					
	Install rigid conduit					
	Install nonmetallic rigid conduit					
	Install cable trays					
	Install flexible conduit					

Unit: Wiring Methods		**10**	**12**	**AD**	**O**	**OJT**
	Install liquid-tight flexible conduit					
	Pull conductors					
	Install ground bonding systems					
	Install various wire connectors					
	Inspect rough installation					
	Prepare for agency inspection					
	Install bus-duct(s), bus-plug(s), and bus-drop(s)					
	Isolate D.C. and communication lines from A.C. lines					
Competency:	**Finish wiring**	**I**	**M**			
Builders:	Install plugs and switches					
	Test plugs and switches					
	Install fixtures					
	Test fixtures					
	Install overcurrent protection					
	Test overcurrent protection					
	Install ground-fault interrupters					
	Test ground-fault interrupters (GFI)					
	Install circuits					
	Test circuits					
	Label circuits					
	Update prints and schematics					
	Dress wiring (e.g., check terminal connections, tie wrap, clean up)					
Competency:	**Prepare for equipment installation**	**I**	**M**			
Builders:	Identify bill of materials					

it: Wiring Methods		10	12	AD	O	OJT
	Identify electrical requirements for equipment					
	Interpret NEC, NFPA, and state and local electrical codes					
	Identify a power distribution source/requirements					
	Interpret symbols					
	Interpret schematics/drawings					
	Prepare site					
Competency:	**Install equipment**					OJT
Builders:	Build control panel					
	Install electrical motor control systems					
	Install electrical motors					
	Install sensors and various input devices					
	Install energy-management systems (e.g., lighting, HVAC, load-shedding)					
	Test equipment and circuits					
	Connect power to equipment					
	Test power to equipment					
Competency:	**Interpret schematics**	I	M			
Builders:	Identify circuit function					
	Interpret electrical symbols					
	Interpret block diagrams					
	Interpret wiring and ladder diagrams					
Competency:	**Trace circuits to locate problems**	I	R	R		
Builders:	Identify circuit type or subsystem					
	Locate specific circuits					
	Use proper troubleshooting technique(s)					

Unit: Wiring Methods		**10**	**12**	**AD**	**O**	**OJ**
Competency:	**Maintain electrical systems**	**I**	**R**	**M**	**O**	
Builders:	Explain root cause of failure					
	Diagnose failure (e.g., infrared testing)					
	Review schematic or ladder diagram					
	Repair or replace defective electrical apparatus					
	Document corrective action needed or taken					
Competency:	**Use soldering tools**		**I**	**M**		
Builders:	Select appropriate soldering tools and supplies for job					
	Perform soldering and desoldering techniques (e.g., micro-miniature, standard)					
Competency:	**Install Class II system**			**I**		**OJT**
builders:	Define Class II systems					
	Comply with local, state, and federal codes, (e.g., NEC, NFPA)					
	Install communication system					
	Install control system					
	Install lighting system					
	Verify system operations					
	Install security systems					
	Install energy management monitoring systems					
	Maintain systems					

Unit:	**Electromechanical Technology**	**10**	**12**	**AD**	**O**	**OJT**
Competency:	**Demonstrate proficiency in reading electromechanical drawings**	I	M	R		
Builders:	Describe types of drawings and their applications					
	Transfer measurements					
	Describe the application of auxiliary views, revolutions, and sectional views					
	Describe dimensioning practices and techniques on drawings					
	Interpret mechanical/electronic production and assembly drawings					
Competency:	**Demonstrate knowledge of electronic sensors and transducers**		I	M		
Builders:	Explain temperature transducers operation					
	Explain stress and strain transducers operation					
	Explain magnetic transducers operation					
	Explain liquid and fluid flow transducers operation					
	Explain fiber optic system operation					
	Explain pressure transducer operation					
Competency:	**Demonstrate proficiency in transducers (sensors) and instrumentation**		I	M		
Builders:	Describe characteristics associated with transducers and instrumentation					
	Describe the principles and operations of various types of transducers (e.g., thermal, shock/vibration, acceleration, positional, pressure, flow, optical, gas and humidity					
	Demonstrate the use of various transducers (e.g., thermal, shock/vibration, acceleration, positional, pressure, flow, optical, gas and humidity)					
	Troubleshoot transducers					

Unit: Electromechanical Technology	10	12	AD	O	OJT
Differentiate between thermocouple types					
Interpret specifications of temperature sensors (e.g., thermocouples, thermistors, resistance temperature devices)					
Interpret specifications of pressure sensors (e.g., strain gage, piezzo electric/piezzo resistive) to electrical circuits					
Interpret specifications of flow sensors (e.g., orifice flow meter, turbine meter, mass flow meters)					
Interpret specifications of speed or position sensor (e.g., tachometer, resolver encoder, linear voltage differential transformer (LVDT)					
Interpret specifications of controllers, indicators, and recorders (e.g., process controllers, programmable logic controllers with interfaces, R-chart recorders, dataloggers/indicators)					
Interpret specifications of final control elements (i.e., silicon controlled rectifiers (SCR), power controllers, motor drives, actuators/robots)					
Describe application circuits					
Calculate specification of proximity sensors					
Calculate specifications of infrared and photo-sensors					
Explain use of proximity sensors					
Explain use of photo electric sensors					
Explain use of mechanically activated switches					
Troubleshoot switch failure					
Describe transducer control and measurement circuits					
Demonstrate the use of control and measurement circuits					
Troubleshoot control and measurement circuits					

t: Electromechanical Technology		10	12	AD	O	OJT
	Repair control and measurement circuits					
Competency:	**Demonstrate proficiency in power distribution systems**		I	M		OJT
Builders:	Describe power distribution systems including power factor					
	Describe poly-phase distribution systems					
	Describe single-phase distribution systems					
	Describe DC distribution systems					
	Describe delta distribution systems					
	Describe wye distribution systems					
	Describe medium-voltage distribution systems					
	Troubleshoot poly-phase distribution systems (e.g., ground faults)					
	Troubleshoot single-phase distribution systems					
	Troubleshoot DC distribution systems					
	Troubleshoot delta distribution systems					
	Troubleshoot wye distribution systems					
	Troubleshoot medium-voltage distribution systems					
Competency:	**Demonstrate proficiency in power distribution equipment**		I	M		OJT
Builders:	Describe power factor correction equipment					
	Describe power transformers					
	Describe power capacitors					
	Describe power oil switches and cutouts					
	Troubleshoot power transformers					
	Troubleshoot power capacitors					
	Troubleshoot power oil switches and cutouts					

Unit: Electromechanical Technology		**10**	**12**	**AD**	**O**	**OJT**
	Describe current transformers					
	Troubleshoot current transformers					
	Describe potential transformers					
	Troubleshoot potential transformers					
	Describe medium-voltage circuit breakers and fuses					
	Troubleshoot medium-voltage circuit breakers and fuses					
	Use medium-voltage safety equipment					
Competency:	**Demonstrate proficiency in motors and motor control circuits**		I	M		OJT
Builders:	Test solid state components with proper instrumentation					
	Test solid state DC motor control circuits					
	Test solid state AC motor control circuits					
	Identify SCR and TRIAC AC control circuits					
Competency:	**Maintain AC and DC motor drives**		I	M		OJT
Builders:	Explain how load is connected to 3-phase wye configured AC generator					
	Identify wye connected and delta connected 3-phase motors					
	Explain revolving fields in AC motors					
	Describe operation of common AC motors					
	Describe operation of variable frequency AC drives					
	Define advantages and disadvantage of common DC motors					
	Explain how motor load affects speed regulation					
	Describe Hall effect in brushless motor control					
	Describe operation of stepper motors					

Unit: Electromechanical Technology		10	12	AD	O	OJT
	Describe speed control of various types of motor drives using sensors					
	Identify defective motors					
	Describe regenerative dynamic braking					
	Describe operation of various feedback loops					
	Describe synchronous motors					
	Describe D.C. motor drive					
	Describe common motor starters (e.g., contractor, relay, smart start, etc.)					
Competency:	**Apply quality control techniques**		I	M		OJT
Builders:	Perform preventative maintenance					
	Perform predictive maintenance (e.g., vibration analysis)					
	Apply statistical process control (SPC)					
	Recalibrate equipment					
	Apply problem-solving tools and techniques					
Competency:	**Apply electromechanical maintenance management practices**		I	M		OJT
Builders:	Keep maintenance records					
	Complete work order					
	Complete internal requisition					
	Complete external requisition					
	Explain planned maintenance					
	Explain breakdown maintenance					
	Explain predictive maintenance					
	Establish maintenance schedules					
	Explain reasons for keeping maintenance records					

Unit: Electromechanical Technology	10	12	AD	O	OJT
Explain reasons for keeping cost records					
Analyze system failure					
Make minor adjustments/repairs					
Coordinate maintenance service					
Make new/replacement equipment recommendations					
Interpret bill of materials for allocation, stocking, and raw material information					
Analyze use of bill of materials for workplace decision making					

Unit: Mechanical Power Transmission	**10**	**12**	**AD**	**O**	**OJT**
Competency: Demonstrate knowledge of basic mechanics	**I**	**R**	**M**		
Builders: Explain working forces of torque, tension, and compression					
Explain the laws of motion					
Explain how to calculate work					
Explain the function of simple machines including levers, inclined plane, wedge wheel and axle, pulley and screw					
Explain the types of power and the method of producing power including compound gears					
Calculate volume mathematically and by displacement					
Explain the laws of friction					
Explain mechanical efficiency					
ompetency: Demonstrate knowledge in mechanical power transmission systems	**I**	**R**	**M**		
Builders: Describe the principles and operation of compound and reverted gear trains					
Describe the principles and operation of internal and planetary gear trains					
Describe the principles and operation of helical and bevel gear trains					
Describe the principles and operation of rack and pinion, worm and wheel and block and screw mechanisms					
Describe the principles and operation of Describe the principles and operation of counter rotating mechanisms and differentials					
Describe the principles and operation of spring mechanisms, pulley blocks and differentials					

Unit: Mechanical Power Transmission		10	12	AD	O	OJT
	Describe the principles and operation of chain, belt and disc drives and universal joints					
	Describe the principles and operation of clutch and coupling mechanisms					
	Describe the principles and operation of braking mechanisms					
	Describe the necessity for proper alignment of mechanical devices					
Competency:	**Use bearings**		I			OJT
Builders:	Define bearing					
	Identify types of bearings and their applications					
	Identify installation method					
	Install bearings					
	Maintain bearings					
	Remove bearings					
Competency:	**Use seals**		I	R		OJT
Builders:	Define seal					
	Identify types of seals and their applications					
	Identify installation method					
	Install seals					
	Maintain seals					
	Remove seals					
Competency:	**Use gears**	I	R	R		OJT
Builders:	Define gears					
	Identify types of gears and their applications					
	Identify installation method					
	Install gears					

Unit: Mechanical Power Transmission		10	12	AD	O	OJT
	Maintain gears					
	Remove gears					
Competency:	**Use sheaves**	I	R	R		OJT
Builders:	Define sheaves					
	Identify types of sheaves and their applications					
	Identify installation method					
	Install sheaves					
	Maintain sheaves					
	Remove sheaves					
Competency:	**Use belts and pulleys**	I	R	R		OJT
Builders:	Define belts and pulleys					
	Identify types of belts and pulleys and their applications					
	Identify installation method					
	Install belts and pulleys					
	Maintain belts and pulleys					
	Remove belts and pulleys					
Competency:	**Use sprockets and chains**		I	R		OJT
Builders:	Define sprockets and chains					
	Identify types of sprockets and chains and their applications					
	Identify installation method					
	Install sprockets and chains					
	Maintain sprockets and chains					
	Remove sprockets and chains					

Unit: Mechanical Power Transmission		**10**	**12**	**AD**	**O**	**OJT**
Competency:	**Use cams and levers**		I	R		OJT
Builders:	Define cams and levers					
	Identify types of cams and levers and their applications					
	Identify installation method					
	Install cams and levers					
	Maintain cams and levers					
	Remove cams and levers					
Competency:	**Use clutches and brakes**			I		OJT
Builders:	Define clutches and brakes					
	Identify types of clutches and brakes and their applications					
	Identify installation method					
	Install clutches and brakes					
	Maintain clutches and brakes					
	Remove clutches and brakes					
Competency:	**Install drive components**		I	R		OJT
Builders:	Identify types of couplings and their applications					
	Identify types of belts and their applications					
	Install solid coupling					
	Install jaw coupling					
	Install molded rubber coupling					
	Install chain type coupling					
	Install a clutch					
	Install brakes					
	Align bearings, bushing, and cams					

Unit: Mechanical Power Transmission		10	12	AD	O	OJT
	Install V-belts and adjust tensions					
	Install a V-belt and manually adjustable sheaves					
	Adjust a V-belt and manually adjustable sheaves					
	Install a V-belt with spring loaded adjustable sheaves					
	Explain the purposes and advantages of a chain drive system					
	Explain the function of speed reducers					
	Explain the function of gears and variable speed reducers					
	Install shafts					
	Align shafts					
	Mount drive sprockets and chains					
	Mount sheaves and pulleys					
	Mount gears on open gear drives					
	Align gears on open gear drives					
	Install a mechanical clutch system					
	Install adjustable speed drives					
	Troubleshoot adjustable speed drives					
	Explain the operation of fluid couplings					
	Install fluid couplings					
	Install torque converters					
	Perform preventive maintenance on drive components					
	Inspect completed work					
Competency:	**Demonstrate proficiency in mechanisms, linkages and levers**		I		R	OJT
Builders:	Describe class one, two, three and compound levers					

Unit: Mechanical Power Transmission		10	12	AD	O	OJT
	Describe the principles and operation of rocker arm and bell crank linkages and combined mechanisms					
	Describe the principles and operation of four-bar mechanisms (crank, rocker, and double rocker)					
	Describe the principles and operation of drag link and intermediate mechanisms					
	Describe the principles and operation of four-bar variations					
	Describe the principles and operation of cam mechanisms					
	Describe the principles and operation of pivoted follower mechanisms					
	Describe the principles and operation of toggle, quick return, and ratchet mechanisms					
	Describe the principles and operation of geneva mechanisms					
Competency:	**Apply lubricants**		I	R		OJT
Builders:	Explain the function of lubricants					
	Explain the properties of oil lubricants and factors determining the selection of lubricants					
	Identify types and functions of lubricant additives					
	Describe types of circulating oils and their purposes					
	Describe lubricating systems, including the charts and methods used					
	Demonstrate proper grease application					
	Demonstrate proper lubricant storage and handling					
	Lubricate a piece of industrial equipment					
	Identify specified lubricant or equivalent					
	Explain lubricant recovery and disposal					

Unit: Precision Machining		10	12	AD	O	OJT
Competency:	**Perform prerequisite machining skills**	I	M			
Builders:	Maintain immediate work area, machinery, and tools					
	Read industrial machining prints					
	Plan work sequence					
	Follow safety rules and regulations					
	Demonstrate math skills (i.e., geometry, trigonometry)					
	Examine variables that determine feeds and speeds					
Competency:	**Analyze machine shop jobs**	I	M			
Builders:	Identify sequence of work on specified project(s)					
	Identify tolerances and finishes on specified project(s)					
	Identify variables that effect job efficiency					
	Explain use of the Machinery Handbook					
Competency:	**Operate metal cutting saw**	I	M			
Builders:	Transfer dimensions from blueprint					
	Clean metal cutting saw					
	Lubricate metal cutting saw					
	Install guides					
	Adjust guides					
	Weld saw blade					
	Install saw blade					
	Examine variables that determine speeds, feeds, and saw blade type					
	Cut metal					
	Deburr workpiece					
	Apply basic metallurgy technology					

Unit: Precision Machining		10	12	AD	O	OJ
Competency:	**Operate drill press**	I	M			
Builders:	Clean drill press					
	Lubricate drill press					
	Mount part					
	Examine variables that determine proper bit and speed					
	Drill part					
	Countersink					
	Counterbore					
	Tap hole					
	Apply basic metallurgy technology					
	Ream hole					
	Center drill hole					
Competency:	**Operate tool and cutter grinding machine**	I	M			
Builders:	Identify parts of machine					
	Select proper wheels and work holding devices (e.g., superabrasives)					
	Perform truing operations					
	Perform dressing operations					
	Perform forming operations					
	Examine variables that determine proper speeds					
	Sharpen end mill					
	Sharpen horizontal milling cutter					
	Sharpen drills and countersinks					
	Apply basic metallurgy technology					

Unit: Precision Machining		10	12	AD	O	OJT
Competency:	**Operate pedestal grinder**	I	M			
Builders:	Clean pedestal grinder					
	Lubricate pedestal grinder					
	Check wheel for defects					
	Mount wheel					
	Position guard and rest					
	Dress wheel					
	Sharpen drill bit					
	Apply basic metallurgy technology					
Competency:	**Operate lathe**	I	M			
Builders:	Clean and lubricate lathe					
	Sharpen tools					
	Mount workpiece					
	Use dial indicator					
	Position guards					
	Examine variables that determine feed(s) and speed(s)					
	Face workpiece					
	Turn shaft					
	Turn taper					
	Knurl workpiece					
	Cut off workpiece					
	Center drill hole					
	Cut threads (all aspects)					
	Turn inside bore					
	Apply basic metallurgy technology					

Unit: Precision Machining		**10**	**12**	**AD**	**O**	**OJT**
	Use live center					
Competency:	**Operate milling machine**	I	M			
Builders:	Clean milling machine					
	Lubricate milling machine					
	Mount workpiece					
	Mount tool					
	Mill surface					
	Mill keyway					
	Drill workpiece					
	Bore with milling machine					
	Mill angle					
	Apply basic metallurgy					
	Select feed(s) and speed(s)					
Competency:	**Operate surface grinder**	I	M			
Builders:	Clean surface grinder					
	Lubricate surface grinder					
	Check wheel for defects					
	Mount wheel					
	Position guard					
	Dress wheel					
	Mount workpiece					
	Set surface grinder					
	Apply basic metallurgy technology					

Unit: Precision Machining		10	12	AD	O	OJT
Competency:	**Select materials**	I	M			
Builders:	Interpret color codes, numbering systems, and classification systems of materials (i.e., ANSI, SAE)					
	Select material for job					
	Identify metals using variety of tests					
Competency:	**Demonstrate basic knowledge of nontraditional machining processes**		I	R		OJT
Builders:	Describe principles of chemical etching					
	List applications of chemical etching					
	List advantages/disadvantages of chemical etching					
	Describe principles of photochemical etching					
	List applications of photochemical etching					
	List advantages/disadvantages of photochemical etching					
	Describe electrical-discharge machining (EDM)					
	List applications of EDM					
	Differentiate between EDM and wire EDM					
	List applications for wire EDM					
	Describe principles of electrochemical machining					
	List applications of electrochemical machining					
	List advantages/disadvantages of electrochemical machining					
	Describe principles of water jet cutting					
	List applications of water jet cutting					
	Describe principles of torch cutting					
	List applications of torch cutting					
	Describe principles of laser cutting					

Unit: Precision Machining		**10**	**12**	**AD**	**O**	**OJT**
	List applications of laser cutting					
	List advantages/disadvantages laser cutting					
Competency:	**Inspect part**	**I**	**R**	**R**		**OJT**
Builders:	Identify appropriate tools for measuring					
	Describe precision, accuracy, tolerance, reliability, and discrimination					
	Distinguish between precision and semiprecision measuring					
	Define standard stock dimensions and tolerances					
	Describe common measurement errors and correction procedures					
	Calibrate measuring machines and devices					
	Demonstrate care of measuring instruments					
	Demonstrate use of rule					
	Demonstrate use of tape					
	Demonstrate use of pi tape					
	Demonstrate use of combination square					
	Demonstrate use of calipers					
	Demonstrate use of micrometers					
	Demonstrate use of dial indicators					
	Demonstrate use of sine bar					
	Demonstrate use of gauges					
	Demonstrate use of surface plate					
	Demonstrate use of protractor					
	Demonstrate use of profilometer					
	Demonstrate use of thermometer					

Unit: Precision Machining		10	12	AD	O	OJT
	Demonstrate use of dividers					
	Demonstrate use of gauge blocks					
	Demonstrate use of threading specs					
	Demonstrate use of optical comparitor					
	Demonstrate use of digital instruments					
	Demonstrate use of electronic gauging equipment					
	Demonstrate use of data acquisition equipment					
	Operate manual coordinate measuring machine					
	Explain use and application of laser alignment/measurement					
Competency:	**Perform basic layouts**	I	M			
uilders:	Use inside diameter (ID), outside diameter(OD), and hermaphrodite calipers					
	Layout with combination square					
	Layout with scriber, divider and trammel					
	Use surface plate					
	Use surface gage					
	Use layout fluid					
	Use V-blocks					
	Use clamps					
	Use angle plate					
	Use parallels					
	Use punches					
	Use transfer methods tools					
	Use layout hammer					
	Use machinist's square					

Unit: Precision Machining	**10**	**12**	**AD**	**O**	**OJT**
Competency: Perform precision layouts	**I**	**M**	**R**		**OJT**
Builders: Use surface plate					
Use surface gage					
Use sine bar					
Use Jo blocks					
Use sine plate					
Use sine vise					
Use planer gage					
Use angle-gage blocks					
Use indicators					
Use universal bevel protractor					
Use coordinate measuring machine (CMM)					

Unit: Programmable Logic Controllers (PLCs)	**10**	**12**	**AD**	**O**	**OJT**
Competency: Explain process controls			**I**	**O**	**OJT**
Builders: Identify types of process controls (i.e., on-off control, closed/open coop, etc.)					
Define proportional control					
Define integral control					
Define derivative control					
Describe advantages of using proportional, integral or derivative control					
Describe disadvantages of using proportional, integral or derivative control					
Competency: Explain programmable controllers			**I**	**O**	**OJT**
Builders: Describe basic applications of PLCs					
Describe basic operation of PLCs					
Identify program symbols and language functions					
Translate relay logic to PLC logic					
Describe function of block transfers					
Describe operation of timers, counters, and sequences					
Describe operation of analog I/O modules					
Describe operation of servo motion control					
Competency: Demonstrate proficiency in automatic controls		**I**	**O**	**OJT**	
Builders: Describe characteristics associated with automatic controls					
Describe the principles and operation of programmable logic controllers					
Demonstrate the use of programmable logic controllers					
Troubleshoot programmable logic controllers					
Repair programmable logic controllers					

Unit: Programmable Logic Controllers (PLCs)		**10**	**12**	**AD**	**O**	**O**
	Write programs for programmable logic controllers					
	Demonstrate the use of a program for programmable logic controllers					
	Troubleshoot a program for programmable logic controllers					
	Repair a probram for programmable logic controllers					
Competency:	**Use programmable controllers**			I	O	OJT
Builders:	Develop process and program flow charts					
	Draw block diagram of PLC					
	Define individual blocks of PLC					
	Describe basic applications(s) of PLCs					
	Describe basic operation of PLCs					
	Identify program symbols and language functions					
	Use operator's and/or manufacturer's manual(s)					
	Write simple logic programs					
	Translate relay logic to logic for PLCs					
	Describe function of block transfers					
	Describe operation of timers, counters and sequences					
	Describe operation of analog I/O modules					
	Describe operation of servo motion control					
	Connect controller to sensors					
	Describe test procedures for new installation of PLC					
	Troubleshoot hardware faults on PLCs					
	Describe safety interlock					
	Describe use of GPP (Graphic programmable panel)					

Unit: Programmable Logic Controllers (PLCs)	**10**	**12**	**AD**	**O**	**OJT**
Competency: Apply robot fundamentals		**I**	**R**	**O**	**OJT**
Builders: Describe the operation of robotic work cells					
Operate robotic work cells					
Troubleshoot robotic work cells					
Classify robots according to industry criteria					
Identify robot power drive types					
Describe positioning in terms of axis, actuators and coordinate system					
Identify types of control systems and sensors					
Apply different methods of programming (e.g., teach, off-line)					
Write simple programs to exercise robot functions					
Join programs to perform full function					
Identify principles of robot safety					
Describe operation of various sensors used in robot control					
Interface sensors to robot					
Interface robots					
Define open loop and closed loop control					
Design a simple automated system to perform manufacturing operation					
Identify operation end effectors					

Unit: Computerized Numerical Control (CNC)		10	12	AD	O	OJT
Competency:	**Demonstrate Knowledge of CNC**		I	R		OJT
Builders:	Define NC and CNC					
	Describe closed loop, open loop, and adaptive controls					
	Define point to point systems					
	Identify tool movement of point to point systems					
	Define continuous path systems					
	Identify tool movements of continuous path systems					
	Identify data input mediums					
	Explain the purpose of the post-processor					
	Define canned cycles					
	Identify computer memory types					
	Identify information stored relative to computer memory types					
	Explain the difference between hardware and software					
	Explain differences among CNC, machining centers, and robots					
	List advantages/disadvantages of CNC machining centers					
	Explain direct numerical control (DNC)					
	Explain rectangular co-ordinate system					
	Describe multi-axis machines					
	Use work address program format					
Competency:	**Apply CNC operations**		I	R		OJT
Builders:	Identify parts of the machine					
	Apply basic programming skills to a turning and/or a milling operation					
	Select proper work holders					

Unit:	**Computerized Numerical Control (CNC)**	**10**	**12**	**AD**	**O**	**OJT**
	Select proper cutting tools					
	Set machine parts to drawing tolerances (e.g., tool offsets)					
	Demonstrate use of CADD/CAM for part program development					
Competency:	**Prepare program**		**I**	**R**		**OJT**
Builders:	Write a program manually in word address format					
	Write a program off line					
	Write a program manually in conversational program					
	Generate a program using CADD/CAM package					
	Program machine using manual data input (MDI) process					
ompetency:	**Program CNC operations**		**I**	**R**		**OJT**
uilders:	Apply ANSI drawing standards					
	Perform process planning from drawing to finished product					
	Inspect workpiece					
	Contrast differences in computer assisted programming					
	Perform basic trigonometric computations					
	Perform CNC special perception mathematical computations					
	Establish chip load, feed rates and surface feet per minute limitations					
	Turn intersection point into segments (i.e., defined in terms of points, lines, and circles)					
	Debug program					
Competency:	**Load machine**		**I**	**R**		**OJT**

Unit: Computerized Numerical Control (CNC)		**10**	**12**	**AD**	**O**	**OJT**
Builders:	Load program from MDI and off-line programming station					
	Prepare work-holding device					
	Mount work-holding device					
	Secure workpiece					
	Set up reference and clearance points					
	Set up tooling					
Competency:	**Operate CNC machine**					OJT
Builders:	Load raw material					
	Start cycle					
	Monitor work in-process					
	Edit CNC programs					
Competency:	**Perform preventive maintenance**					O[illegible]
Builders:	Follow proper safety procedures					
	Clean CNC equipment					
	Lubricate CNC equipment					
	Check CNC equipment for wear and alignment					

Unit: Hydraulics and Pneumatics		10	12	AD	O	OJT
Competency:	**Explain fluid flow concepts**	I	R	M		
Builders:	Explain relationship of heat to hydraulics					
	Explain Pascal's Law					
	Explain Boyle's Law					
	Explain Bernoulli's Principle					
	Describe flow velocity					
	Explain how heat and pressure relate to power and transmission					
	Describe physical and chemical properties of a fluid					
	Describe fluids in motion in closed conductors					
	Describe continuity of mass flow					
	Identify types of fluids					
	Identify properties of fluids					
	Identify units of measurement for pressure, density, and viscosity					
Competency:	**Describe energy considerations**	I	R	M		
Builders:	Differentiate work and power					
	Differentiate potential and kinetic energy					
	Explain energy conservation concept					
	Explain hydraulic horsepower					
	Explain work of compression in compressible fluids					
Competency:	**Describe system losses**	I	R	M		
Builders:	Differentiate turbulent and laminar flow					
	Explain friction factor					
	Explain pressure losses					

Unit: Hydraulics and Pneumatics		10	12	AD	O	OJT
	Identify potential system losses (e.g., leaks, wear, component sizing, dirt)					
	Explain fluid breakdown					
Competency:	**Explain hydrostatics**	I	R	M		
Builders:	Explain pressure, density, and viscosity					
	Explain buoyancy					
	Explain equilibrium					
Competency:	**Calculate energy**	I	R	M		
Builders:	Apply Pascal's Law					
	Apply Bernoulli's Principle					
	Apply Boyle's Law					
	Calculate work and power					
	Calculate potential and kinetic energy					
	Calculate hydraulic horsepower					
	Calculate flow velocity and pressure					
	Calculate pressure losses					
	Calculate laminar flow					
	Calculate pump capacity					
	Calculate system requirements					
Competency:	**Design basic hydraulic/pneumatic system**	I	R	M		
Builders:	Use common symbols					
	Create circuit diagrams (i.e., schematics)					
	Diagram closed-loop hydraulic system					
	Diagram an air supply system					

Unit: Hydraulics and Pneumatics		10	12	AD	O	OJT
	Differentiate between pneumatics for process measurement such as air logic and high pressure for power tools and machines					
Competency:	**Explain component operation**	I	R	M		
Builders:	Identify functions and operation of hydraulic components					
	Identify functions and operation of pneumatic components					
	Explain application(s) of different materials (e.g., plastic, copper)					
Competency:	**Troubleshoot hydraulic and pneumatic circuits**					OJT
Builders:	Analyze hydraulic circuits					
	Troubleshoot hydraulic circuits					
	Analyze pneumatic circuits					
	Trouble shoot pneumatic circuits					
Competency:	**Perform pump maintenance repair**			I		OJT
Builders:	Identify pump capacity and system requirements					
	Explain packing and seal requirements					
	Explain operating principles of pumps (e.g., centrifugal, propeller and turbine rotary, metering)					
	Perform pump maintenance					
	Disassemble a pump					
	Reassemble a pump					
Competency:	**Maintain piping and accessories for high and low pressure fluid power systems**			I		OJT
Builders:	Identify components of a piping system					
	Explain maintenance features of both metallic and non-metallic piping systems					

Unit: Hydraulics and Pneumatics		**10**	**12**	**AD**	**O**	**OJT**
	Explain types of valves and their operation and maintenance					
	Explain use and maintenance of strainers, filters, and traps in piping systems					
	Join common fittings					
	Join metallic pipe					
	Join plastic pipe					
	Join copper and steel tubing					
	Bend copper and steel tubing					
	Cut copper and steel tubing					
	Explain relevant industry standards					
Competency:	**Maintain hydraulic system components**			I		OJT
Builders:	Explain how heat and pressure relate to power and transmission					
	Describe physical and chemical properties of a fluid					
	Replace a contaminant removal system					
	Maintain a contaminant removal system					
	Explain operation and use of heat exchangers					
	Identify reservoir requirements					
	Select pumps for specific applications					
	Compute hose requirements					
	Replace hydraulic lines					
	Select control valves and servo-type valves					
	Replace control valves and servo-types valves					
Competency:	**Troubleshoot hydraulic systems**					OJT
Builders:	Interpret hydraulic schematic					

Unit: Hydraulics and Pneumatics		10	12	AD	O	OJT
	Connect electrically controlled valves					
	Explain hydraulic system troubleshooting techniques					
	Repair or replace hydraulic valves					
	Repair or replace hydraulic cylinders					
	Repair or replace hydraulic pumps and motors					
	Install hydraulic components					
	Use text equipment to troubleshoot					
	Apply safety guidelines					
Competency:	**Describe reciprocating and rotary air compressors**			I		OJT
Builders	Explain relationship of force, weight, mass, and density in pneumatic system					
	Explain operation of reciprocating compressors					
	Explain operation of rotary compressors					
	Explain primary and secondary air treatment (e.g., air dryers, lubricating systems)					
	Explain operation of compressor valves, cylinders, and motors					
Competency:	**Maintain pneumatic systems**					OJT
Builders:	Repair or replace pneumatic system components					
	Explain pneumatic system maintenance techniques					
	Explain pneumatic system troubleshooting procedures					
	Isolate faults in air compressors					
	Isolate faults in control valves					
	Repair or replace control valves					
	Isolate faults in air motors					
	Repair or replace air motors					

Unit: Hydraulics and Pneumatics		**10**	**12**	**AD**	**O**	**OJT**
	Isolate faults in air dryers					
	Repair or replace air dryers					
	Maintain proportioning and servo valves					
	Use test equipment to troubleshoot					
	Apply safety guidelines					
	Lubricate pneumatic system(s)					
Competency:	**Troubleshoot pneumatic systems**			I		OJT
Builders:	Identify the schematic symbols and diagrams used in pneumatic systems					
	Diagram an air supply system					
	Repair or replace pneumatic system components					
	Explain pneumatic system troubleshooting procedures					
	Troubleshoot air compressors					
	Troubleshoot pneumatic control valves					
	Troubleshoot air motors					
	Troubleshoot air dryers					
Competency:	**Maintain vacuum systems**			I		OJT
Builders:	Describe characteristics associated with vacuum systems and sub-atmospheric pressure					
	Describe the principles and operation of vacuum gauges					
	Demonstrate use of vacuum gauges					
	Repair or replace vacuum gauges					
	Describe the principles and operation of vacuum pumps					
	Demonstrate use of vacuum pumps					
	Repair or replace vacuum pumps					

Unit: Hydraulics and Pneumatics	10	12	AD	O	OJT
Describe the principles and operation of vacuum controls					
Demonstrate use of vacuum controls					
Repair or replace vacuum controls					

Unit: Basic Drafting		10	12	AD	O	OJT
Competency: Apply basic drafting skills		I	R	M		
Builders:	Describe types of blueprints and their applications					
	Use drafting equipment, measuring scales, drawing media, drafting instruments and consumable materials					
	Identify line styles, weights (alphabet of lines)					
	Select proper drawing scale					
	Prepare title blocks and other drafting formats					
	Apply various freehand and other lettering techniques					
	Apply isometric, oblique and perspective sketching techniques					
	Prepare isometric, oblique and perspective sketches					
	Interpret reports and specifications					
	Prepare multi-view drawings					
	Prepare sectional views					
	Prepare auxiliary views					
	Prepare pictorial drawings					
	Prepare multi-view sketches					
	Prepare orthographic views					
	Prepare change control block					
	Describe change control propose and procedure					
	Interpret drawings/schematics					
	Identify ANSI symbols					
	Prepare views of drilled and tapped holes, counterbores, countersinks					
	Draw horizontal, vertical, angular, parallel, and perpendicular lines					

Unit: Basic Drafting		**10**	**12**	**AD**	**O**	**OJT**
	Draw horizontal, vertical, angular, parallel, and perpendicular lines					
	Measure an angle					
	Transfer an angle					
	Construct tangent lines (to arcs) and tangent arcs (to arcs)					
	Bisect angles and arcs					
	Bisect lines					
	Divide lines					
	Construct three-point circle					
	Construct regular hexagon, pentagon, and octagon					
	Reproduce a drawing					
	Prepare single-view drawings					
	Prepare dimension drawings					
	Apply systems drafting techniques					
	Identify a bill of materials					
	Interpret notes and dimensions to determine part					
	Dimension drawings using ANSI and 14.5 standard					
	Draw arcs, circles, and conics					
	Describe purpose of auxiliary and sectional views					
	Interpret basic pneumatic/hydraulic standards and symbols					
	Transfer measurements					
	Interpret various drawings (e.g., welding, casting, stamping, forging, civil, mops, pattern shops)					
Competency:	**Read blueprints**	I	M			
uilders:	Visualize object from drawing					

Unit: Basic Drafting		10	12	AD	O	OJT
	Comprehend orthographic projections					
	Comprehend isometric views					
	Comprehend sectional views					
	Comprehend detail and assembly drawings					
	Interpret dimensions					
	Interpret tolerances					
	Interpret GD&T characteristic symbols					
	Interpret GD&T supplementary symbols					
	Interpret screw thread specifications					
	Identify structural steel shapes					
	Interpret special symbols					
Competency:	**Demonstrate knowledge of basic geometric dimensioning and tolerancing**	I	R	M		
Builders:	Identify geometric characteristics and symbols (i.e., flatness, straightness, roundness, cylindricity, profile of line, profile of surface, perpendicularly, angularity, parallelism, circular, runout, total indicated runout, position, concentricity, and symmetry)					
	Define maximum material condition					
	Define least material condition					
	Define regardless of feature size condition					
	Describe feature control blocks					
	Describe datum surfaces and targets					
	Define flatness (pitch)					
	Define straightness (yaw)					
	Define roundness					
	Define cylindrically					

Unit: Basic Drafting	**10**	**12**	**AD**	**O**	**OJT**
Define profile of line					
Define profile of surface					
Define perpendicularity					
Define angularity					
Define parallelism					
Define circular runout					
Define total runout					
Apply true position concept to determine tolerance for location of holes in mating parts					
Convert dimensions and tolerances from English units to metric units					
Convert dimensions and tolerances from metric units to English units					
Competency: Demonstrate dimensioning techniques	**I**	**R**	**M**		
Builders: Construct arrowheads					
Dimension arcs					
Dimension angles					
Dimension curves					
Dimension rounded-end shapes					
Dimension spherical objects					
Dimension cylindrical objects					
Dimension cones, pyramids, and prisms					
Dimension features on circular center line					
Dimension theoretical point of intersection					
Dimension object using rectangular coordinate system					
Dimension object using polar coordinate system					

Unit: Basic Drafting		10	12	AD	O	OJT
	Dimension object using tabular coordinate system					
	Dimension object using ordinate dimensioning system					
	Apply symbols for surface and texture control					
	Add notes to drawing					
	Interpret decimal tolerance dimensions					
Competency:	**Prepare basic charts and graphs**	I	M			
Builders:	Prepare line, bar, pie, and surface charts					
	Prepare polar rectangular and semi-logarithmic graphs					
	Prepare flow charts					
Competency:	**Apply geometric dimensioning and tolerancing**		I	M	O	OJT
Builders:	Interpret decimal tolerance dimensions					
	Calculate clearance fit tolerances of mating parts					
	Dimension clearance fit tolerances of mating parts					
	Calculate interference fit tolerances of mating parts					
	Dimension interference fit tolerances of mating parts					
	Calculate tolerances to mating parts using standard fit tables					
	Assign tolerances to mating parts using standard fit tables					
	Apply positional and form tolerancing symbols					
	Apply symbols for true position					
	Apply symbols for maximum material control and regardless of feature size					

Unit:	**Fundamentals of CADD Technology**	10	12	AD	O	OJT
Competency:	**Operate a CADD system**		M	R	O	
Builders:	Load CADD system					
	Start CADD system					
	Utilize keyboard input					
	Utilize screen and tablet menus					
	Utilize other input devices					
	Create scaled plots					
	Operate a pen plotter					
	Operate a printer-plotter					
	Access on-line help for commands					
Competency:	**Select entities for action**		M	R	O	
uilders:	Add or remove entities to the selection set separately					
	Add or remove entities to the selection set using a window					
	Add or remove entities to the selection set with a crossing-box					
	Select entities using a fence					
	Select entities by other methods (e.g., last, previous, all, etc.)					
Competency:	**Create 2-D orthographic drawings**		M	R	O	
Builders:	Create primitive drawing entities					
	Draw utilizing absolute Cartesian coordinates					
	Draw utilizing relative Cartesian coordinates					
	Draw utilizing polar coordinates					
	Draw using construction aides (e.g., snaps, grid, snap, etc.)					
	Set current color					

Unit: Fundamentals of CADD Technology		10	12	AD	O	OJT
	Set linetypes					
	Load linetypes					
	Control scaling of linetypes					
	Edit drawing entity properties (e.g., color, layer, thickness, linetype)					
	Construct drawing entities (e.g., offset, timer, extend, break, mirror, etc.)					
	Edit drawing entities (e.g., offset, trim, extend, break, mirror, etc.)					
	Set system variables					
	Utilize system variables					
	Create layers					
	Name layers					
	Manipulate layers					
	Save files					
	Create back-ups					
	Identify reasons for back-up					
Competency:	**Dimension orthographic drawings**		M	R	O	
Builders:	Create dimensions					
	Edit dimensions					
	Control dimension variables					
Competency:	**Annotate orthographic drawings**		M	R	O	
Builders:	Create text styles					
	Edit text styles					
	Select text styles					
	Apply notes					

Unit: Fundamentals of CADD Technology	**10**	**12**	**AD**	**O**	**OJT**
Competency: Control display		**M**	**R**	**O**	
Builders: Apply view control while drawing (e.g., zoom and pan)					
Control view resolution (e.g., viewers)					
Create slides					
Display slides					
Save view					
Display views					
Competency: Extract entity and drawing information		**M**	**R**	**O**	
Builders: Measure distances					
Measure areas					
Identify locations					
List entity characteristics (e.g., length, size, location, properties, etc.)					

Unit: Intermediate CADD Technology		10	12	AD	O	OJT
Competency:	**Manage symbols and attributes**		M	R	O	
Builders:	Create blocks and W-blocks					
	Create nested blocks					
	Insert blocks and drawings					
	Redefine blocks					
	Edit blocks					
	Create or define attributes					
	Insert attributes					
	Edit attributes					
	Purge entities in a file					
Competency:	**Create 2-D isometric drawings**		M	R	O	
Builders:	Manipulate snap and grid settings					
	Toggle planes (e.g., left, right, top)					
	Create text styles for each plane					
	Create dimension styles in isometric					
	Create isometric ellipses					
Competency:	**Create custom menus**		M	R	O	
Builders:	Demonstrate search routines when using a text editor					
	Write screen menus and macros					
	Write tablet menus and macros					
	Write cascading pop-down menus and macros					
	Write icon menus and macros					
	Write button menus and macros					
	Write other customizable CADD files (e.g., ACADD.PCP)					

Unit: Intermediate CADD Technology		10	12	AD	O	OJT
	Edit other customizable CADD files (e.g., ACADD.PCP)					
Competency:	**Create script files**		M	R	O	
Builders:	Write a slide show script					
	Write a script for setting initial variable settings					
	Write a script for creating a title-block					
Competency:	**Create custom linetypes**		M	R	O	
Builders:	Formulate a linetype composed of long dashes					
	Formulate a linetype composed of lines, dashes and dots					
Competency:	**Create custom hatch patterns**		M	R	O	
Builders:	Create a new hatch pattern file					
	Edit the existing ACADD.PAT file					
Competency:	**Create 3-D wireframe models**		M	R	O	
Builders:	Explain the difference between extrusions, wireframes, surface models, and solid models					
	Create user coordinate systems					
	Manipulate user coordinate systems					
	Utilize cylindrical coordinates					
	Utilize spherical coordinates					
	Project geometry from one plane to another					
Competency:	**Create 3-D surface models**		M	R	O	
Builders:	Define B-rep surfaces					
	Explain the difference between B-rep surfaces and non-uniform rational B-splines (NURB's)					
	Create tabulated surfaces					
	Create ruled surfaces					

Unit: Intermediate CADD Technology		10	12	AD	O	OJT
	Create revolved surfaces					
	Create edge surfaces (coon's patch)					
	Apply surface meshes to 3-D wireframes					
	Modify visibility of the edges of faces					
	Dimension of a 3-d model for both isometric and orthographic drawings					
	Control dimension scale with regard to plotting scale					
Competency:	**Utilize advanced plotting techniques**		M	R	O	
Builders:	Define camera viewpoints and angle of rotation					
	Control display angle (e.g., dview, vpoint)					

Unit: Advanced CADD Technology		**10**	**12**	**AD**	**O**	**OJT**
Competency:	**Create 3-D solid models**			M	O	
Builders:	Differentiate between B-rep solid modeling and Constructive Solid Geometry (CSG) modeling					
	Create solid primitives					
	Modify solid primitives					
	Create swept solids					
	Utilize Boolean operations to create complex solids (e.g., unions, subtraction's, intersections, separations)					
	Fillet solid models					
	Chamfer solid models					
	Extract mass properties from a solid model					
	Create 2-D profiles and sections from a solid model					
	Explain the limitations of solid modeling					
Competency:	**Apply advanced display control**			M	O	
Builders:	Utilize clipping planes to section a model					
	Apply perspective views					
	Place camera and target points to locate views					
	Place lights for rendering					
	Control lights for rendering					
	Create rendered images of surface and solid models					
Competency:	**Configure a CADD station**			M	O	
Builders:	Install CADD software					
	Configure display drivers					
	Configure printer/plotter drivers					
	Configure input drivers					

Unit: CADD Applications		**10**	**12**	**AD**	**O**	**OJT**
Competency:	**Apply CADD drafting skills or drawing media**			**M**	**O**	**OJT**
Builders:	Create detail drawing(s) including basic machine elements (e.g., fasteners, gears, springs, bearing, holes, threads, welds)					
	Differentiate between a drawing for machining and patterns					
	Prepare assembly drawing including bill of materials					
	Create a block library					
	Perform fundamental customization					
	Import external data (e.g., IGES, DXF, STL)					
Competency:	**Use CADD to prepare drawings**			**M**	**O**	**OJT**
Builders:	Log in on PC or work station					
	Load CADD software					
	Load title bock					
	Load existing drawing					
	Merge drawing files					
	Create features (e.g., lines, circles, ellipses, splines, text) using keyboard and/or mouse or digitizer					
	Dimension drawing using ANSI y 14.5 geometric dimensioning and tolerancing					
	Use CADD program functions (e.g., line parallel to offset, cross hatch, copy, move, rotate, cut, trim) to improve productivity					
	Produce drawing including auxiliary and section views					
	Plot drawing					
	Prepare symbol library (e.g., electrical/electronic, electrical/hydraulic, welding)					
	Construct a solid model					

Unit: CADD Applications		10	12	AD	O	OJT
	Prepare CADD drawing for use in CAM environment					
Competency:	**Prepare basic computer-aided drawings**			M	O	OJT
Builders:	Use a digitizer					
	Use a plotter					
	Select the proper drawing scale					
	Produce charts and graphs					
	Produce multi-view drawings with dimensions					
	Produce sectional view drawings with dimensions					
	Produce auxiliary view drawings with dimensions					
	Produce pictorial drawings					
	Operate CAD terminal					
	Utilize system commands					
	Perform drafting procedures					
	Operate peripheral equipment					
	Use solid modeling to calculate mass properties to solve design problems					
Competency:	**Prepare mechanical drawings**			M	O	OJT
Builders:	Interpret basic mechanical standards and symbols					
	Prepare assembly drawings					
	Prepare welding drawings					
	Prepare bearing drawings					
	Prepare casting drawings					
	Prepare forging drawings					
	Prepare tool drawings					
	Prepare molding diagrams					

Unit: CADD Applications		10	12	AD	O	OJT
	Prepare drawings with special processed holes					
	Prepare stamping drawings					
	Prepare numerical control drawings					
	Produce installation drawings					
Competency:	**Prepare advanced mechanical drawings**			M	O	OJT
Builders:	Resolve problems by descriptive geometry and revolutions					
	Prepare advanced surface drawings					
	Use precision dimensioning to include geometric characters					
	Use precision measuring instruments (e.g., calipers)					
	Make engineering changes on drawings					
	Prepare fastener drawings					
	Prepare cam drawings					
	Prepare gear drawings					
	Prepare spring drawings					
	Prepare pulley and chain drive drawings					
Competency:	**Prepare electrical/electronic CADD drawings**			M	O	OJT
Builders:	Interpret basic electric/electronic standards and symbols					
	Prepare schematic drawings					
	Prepare cable drawings					
	Prepare component drawings					
	Prepare logic diagrams					
	Prepare control panel drawings					
	Prepare connection drawings					

Unit: CADD Applications		10	12	AD	O	OJT
	Prepare interconnection drawings					
	Prepare printed circuit board drawings					
	Prepare harness drawings					
	Prepare packaged drawings					
	Prepare wiring diagrams					
	Prepare enclosure drawings					
	Produce installation drawings					
	Prepare flow charts					
	Prepare symbol library					
	Modify drawings					
Competency:	**Prepare pneumatic/hydraulic CADD drawings**			M	O	OJT
uilders:	Interpret basic pneumatic/hydraulic standards and symbols					
	Prepare piping drawings					
	Prepare isometric drawings					
	Prepare sectional diagrams					
	Prepare graphical symbols					
	Prepare process and instrumentation diagrams					
	Prepare combination diagrams					
	Prepare pump and motor drawings					
	Prepare cylinder and piston diagrams					
	Prepare valve drawings					
	Prepare pump section drawings					
	Produce installation drawings					
	Prepare symbol library					

Unit: CADD Applications	**10**	**12**	**AD**	**O**	**OJT**
Competency: Prepare structural CADD drawings			**M**	**O**	**OJT**
Builders: Use structural member and reinforcing concrete manuals and technical tables					
Detail structural beam connections					
Detail concrete reinforcements					
Prepare materials take off list					
Draw structural framing plans and elevations					
Identify welding symbols					
Prepare symbol library					

TECH PREP

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TCP Matrix

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Engineering Technologies Cluster Tech-Prep Competency Profile Matrix

(Shaded areas indicate core units.)

ET = Electronics Technician
EL = Electrical Maintenance Technician
IC = Instrumentation Control Technician
EM = Electromechanical Technician
MT = Mechanical Technician
IM = Industrial Manufacturing Technician
CT = CADD Technician
TD = Tool & Die Technician
PT = Plastics Technician
QC = Quality Control Technician
CS = Computer Systems Technician
CP = Computer Programming Technician

UNIT	ET	EL	IC	EM	MT	IM	CT	TD	PT	QC	CS	CP
Communications Literacy	X	X	X	X	X	X	X	X	X	X	X	X
Mathematics Literacy	X	X	X	X	X	X	X	X	X	X	X	X
Science Literacy	X	X	X	X	X	X	X	X	X	X	X	X
Technology Literacy	X	X	X	X	X	X	X	X	X	X	X	X
Employability Skills	X	X	X	X	X	X	X	X	X	X	X	X
Professionalism	X	X	X	X	X	X	X	X	X	X	X	X
Teamwork	X	X	X	X	X	X	X	X	X	X	X	X
Quality Assurance	X	X	X	X	X	X	X	X	X	X	X	X
Technical Recording and Reporting	X	X	X	X	X	X	X	X	X	X	X	X
Computer Literacy	X	X	X	X	X	X	X	X	X	X	X	X
Workplace Safety	X	X	X	X	X	X	X	X	X	X	X	X
Supervision			X	X	X	X	X				X	X
Basic Electronics	X	X	X	X		X					X	
Fundamentals of Electronics Technology	X	X	X			X						
Troubleshooting and Repair	X	X	X	X	X	X				X		
Microcomputer Electronics Technology	X	X									X	X
Instrumentation and Control Technology	X		X									
Communications Electronics Technology	X	X										
Electro-optic Technology		X										
Electronic Product Servicing Technology		X										
Industrial Electricity	X	X	X	X	X	X					X	
Electrical Test and Measurement Equipment	X	X		X		X						
Wiring Methods		X										
Drafting Technology	X	X	X	X	X	X	X	X		X		X
CADD Fundamentals	X	X	X	X	X	X	X	X		X		X
Intermediate CADD	X			X	X		X					
Advanced CADD							X					

Engineering Technologies Cluster Tech-Prep Competency Profile Matrix

(Shaded areas indicate core units.)

ET = Electronics Technician
EL = Electrical Maintenance Technician
IC = Instrumentation Control Technician
EM = Electromechanical Technician
MT = Mechanical Technician
IM = Industrial Manufacturing Technician
CT = CADD Technician
TD = Tool & Die Technician
PT = Plastics Technician
QC = Quality Control Technician
CS = Computer Systems Technician
CP = Computer Programming Technician

UNIT	ET	EL	IC	EM	MT	IM	CT	TD	PT	QC	CS	CP
Equipment Installation	X		X	X	X	X						
Equipment Maintenance	X	X			X	X		X		X		
Mechanical Power Transmission				X	X	X						
Electromechanical Technology	X	X		X	X	X						
Precision Machining					X	X		X				
Fundamentals of Machine Anatomy		X			X	X	X					
Hydraulics and Pneumatics	X	X	X	X	X	X			X			
Industrial Manufacturing Technology		X	X	X	X	X						
Programmable Logic Controllers (PLCs)	X	X		X	X	X						
Computerized Numerical Control (CNC)		X			X	X	X	X				
Industrial Engineering Basics					X	X				X		
Basic Materials Science					X	X	X	X		X		
Welding Basics					X	X		X		X		
Basic Diemaking								X				
Metal Stamping Dies					X	X	X	X				
Press Technology					X	X	X	X				
Sheet Metal Fabrication					X	X	X	X				
Basic Moldmaking								X	X			
Polymer Technology									X			
Polymeric Testing									X	X		
Polymer Extrusion and Molding									X			
Computer Hardware Design											X	
Application Programming and Design												X
Local Area Network (LAN) Operations											X	X

Occupational Definitions
Engineering Technologies Cluster

The following definitions broadly describe 12 occupations within the Engineering Technologies Cluster. While the definitions identify some technical skills necessary to gain employment at the technician level, the TCP Matrix offers a list of units needed for a Tech Prep program in one or more of the following occupations. Shaded units are considered core units within a program, whereas unshaded units may or may not be necessary for employment, depending upon labor market demands.

Electronics Technician—An individual who combines electrical, electronic, and mechanical functions and their interactions. Technical skills should include, but not be limited to:

- quality control and safety devices
- microcomputer applications in industry
- electronic applications of communication equipment
- design and assembly of electronic units
- teamwork skills
- report preparation

Electrical Maintenance Technician—An individual who applies basic engineering principles and technical skills supporting electrical, electronics, and communication engineers. Technical skills should include, but not be limited to:

- electrical circuitry
- prototype development and testing
- systems analysis and testing
- systems maintenance and repair
- instrument calibration
- teamwork skills
- report preparation

Instrumentation Control Technician—An individual who devises, selects, sets up, and operates electronic instrumentation and electromechanical or electrohydraulic apparatus used for operational and environmental testing of mechanical, structural, or electrical equipment. Technical skills should include, but not be limited to:

- systems analysis, testing, and maintenance
- instrumentation design, calibration, and maintenance
- instrumentation and electrical circuitry sensing, telemetering, and recording
- design and production testing and scheduling of automated equipment functions
- nonstandard apparatus specification development
- test data analysis and conversion
- teamwork skills
- report preparation

Electromechanical Technician—An individual who applies electrical theory and related knowledge to test and modify developmental or operational electrical machinery and electrical control equipment and circuitry in industrial settings. Technical skills should include, but not be limited to:
- causes of electrical or mechanical malfunction or failure of equipment
- preventative and corrective maintenance
- equipment modification and/or replacement
- mechanical and electrical equipment and systems testing, troubleshooting, repair, and modification
- test data analysis and interpretation
- adjustment, calibration, alignment, and modification of circuitry and components
- teamwork skills
- report preparation

Mechanical Technician—An individual who applies mathematics and physical principles to design, troubleshoot, or use mechanical, hydraulic, or electromechanical devices or systems. Technical skills should include, but not be limited to:
- workplace safety
- CADD skills
- basic electronics
- physics principles and their applications
- materials used in industry and their physical properties
- product, machinery, and systems design
- teamwork skills
- report preparation

Industrial Manufacturing Technician—An individual who applies basic engineering principles and technical skills in support of engineers and other professionals engaged in developing and/or using manufacturing systems and processes. Technical skills should include, but not be limited to:
- machining skills
- print and schematic interpretation
- geometric dimensioning and tolerancing
- basic CADD skills
- basic electrical skills
- computerized numerical control
- programmable logic controllers
- operational diagnosis, repair, and maintenance procedures
- manufacturing methods specification and implementation
- statistical process control
- teamwork skills
- report preparation

CADD Technician—**An individual who applies technical knowledge and skills to plan and prepare computerized pictorial interpretations of plans and design concepts for mechanical devices and machinery. Technical skills should include, but not be limited to:**

- print and schematic interpretation
- proficient drafting and CADD/CAM skills
- drawing designs from approved sketches
- drawing designs from blueprints, designs, mockups, and photoprints
- layouts, drawings, and schematics depicting function, relationship, and assembly sequence of parts and assemblies
- teamwork skills
- report preparation

Tool and Die Technician—**An individual who designs, prepares, and produces production dies to use in industrial manufacturing processes. Technical skills should include, but not be limited to:**

- quality control and safety devices
- drafting/CADD skills
- welding basics
- advanced machining skills
- precision/accuracy skills
- teamwork skills
- report preparation

Plastics Technician—**An individual who applies basic engineering principles and technical skills in support of engineers and other professionals engaged in developing and using industrial manufacturing systems and processes. Technical skills should include, but not be limited to:**

- principles of macromolecular chemistry
- polymerization and plastic manufacturing processes and equipment
- design and operational testing procedures
- equipment maintenance and repair procedures
- safety procedures
- teamwork skills
- report preparation

Quality Control Technician—**An individual who applies basic engineering principles and technical skills in support of engineers and other professionals engaged in maintaining consistent manufacturing and construction standards. Technical skills should include, but not be limited to:**

- quality control systems management principles
- technical standards applicable to specific engineering and manufacturing projects
- testing and inspection procedures
- related instrumentation and equipment operation and maintenance
- teamwork skills
- report preparation

Computer Systems Technician—**An individual who analyzes data processing requirements and plans the layout, installation, or modification of new or existing data processing system(s) that provide capabilities for projected work loads. Technical skills should include, but not be limited to:**

- minor microcomputer hardware and software system repairs
- hardware and peripheral component installation
- software package loading and documentation
- system hardware, software, and operator problem diagnosis
- user instruction and documentation of equipment, software, and manuals
- microcomputer circuitry development to support network and I/O interface(s)
- teamwork skills
- report preparation

Computer Programming Technician—**An individual who designs, interfaces, installs, and troubleshoots industrial computer systems. Technical skills should include, but not be limited to:**

- high level of electronics applications
- computer languages and their applications
- interfacing microprocessor and microcontroller-based systems with other peripheral equipment (e.g., motors, transducers)
- integrating and troubleshooting hardware and software
- teamwork skills
- report preparation

TECH PREP

"GET SERIOUS . . . ABOUT SUCCESS"

Essential Competencies

These units appear in each of the individual occupations as well as in the various cluster combinations. Individual unit content may vary slightly due to program emphasis, yet these competencies should be viewed as essential to Tech Prep success within Engineering Technologies.

Units:	Page
Communications Literacy	EC-1
Mathematics Literacy	EC-12
Science Literacy	EC-18
Technology Literacy	EC-29
Employability Skills	EC-30
Professionalism	EC-35
Teamwork	EC-39
Quality Assurance	EC-41
Technical Recording and Reporting	EC-51
Computer Literacy	EC-52
Workplace Safety	EC-54

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Unit: Communications Literacy

NOTE: This content was extracted from the 9-12 cluster of Ohio's Model Language Arts Program. Due to statewide initiatives other than Tech Prep, this literacy unit was not altered to meet competency-based criteria. Each literacy unit forms a critical link between academic teachers and members of business, industry, and labor. [See "The TCP Process" for more information.]

Subunit: Reading—Structure

Competencies:

RS1 Exhibit knowledge of language structure
RS2 Recognize that there may be more than one interpretation of reading selections
RS3 Recognize various literary devices
RS4 Recognize and discuss literary elements
RS5 Develop and use an increasingly sophisticated vocabulary gained through context
RS6 Apply knowledge of language structure to reading
RS7 Explain why there may be more than one interpretation of reading selections
RS8 Recognize effect of literacy devices on meaning
RS9 Analyze author's use of literary elements
RS10 Recognize relationship of structure to meaning
RS11 Describe various interpretations and meaning levels in reading selections
RS12 Characterize author's use of literary devices
RS13 Characterize use of literary techniques
RS14 Critique a variety of literature with regard to plot, dialogue, theme, setting, and characterization
RS15 Apply an expanding vocabulary gained through reading
RS16 Explain various interpretations and meaning levels in reading selections
RS17 Analyze use of literary techniques (e.g., extended metaphor, simile, personification, hyperbole, pun, alliteration)
RS18 Understand use of literary devices (e.g., irony, satire, allegory, onomatopoeia)
RS19 Analyze and synthesize pieces of literature with regard to plot, dialogue, theme, setting, and characterization

Subunit: Reading—Meaning Construction
Competencies:

RM1	Demonstrate ability to recognize appropriate pre-reading strategies
RM2	Describe effectiveness of a reading selection
RM3	Read to clarify personal thinking and knowledge
RM4	Support interpretation of text by locating and citing specific information
RM5	Develop personal response to a variety of literary works
RM6	Recognize diverse literary interpretations
RM7	Engage in self-selected reading activities
RM8	Confirm and extend meaning in reading by researching new concepts and facts
RM9	Self-monitor and apply corrective strategies when communication has been interrupted or lost
RM10	Use features of literary genres to extend meaning
RM11	Assess effectiveness of a selection read
RM12	Use reading as a possible problem-solving strategy to clarify personal thinking and knowledge
RM13	Use knowledge of semantic elements (e.g., figurative language, denotation, connotation, dialect) to clarify meaning when reading
RM14	Predict, recognize, interpret, and analyze themes based on familiarity with author's work
RM15	Compare and contrast literary genres
RM16	Assess validity and quality of selection read
RM17	Clarify meaning when reading
RM18	Compare personal reaction to critical assessment of a literary selection
RM19	Assess validity of diverse literary interpretations
RM20	Use reference books to find, evaluate, and synthesize information
RM21	Identify tone of a literary work
RM22	Critique validity of diverse literary interpretations
RM23	Integrate personal reaction to and critical assessment of a literary selection

Subunit: Reading—Application

Competencies:

RA1 Select and read material for personal enjoyment and information
RA2 Read a variety of complete, unabridged works
RA3 Employ various reading strategies according to purpose
RA4 Participate in selection of books, materials, and topics for literature study groups
RA5 Develop and apply knowledge of the interrelationship of concepts
RA6 Read selections from a variety of styles and formats, recognizing that style and format influence meaning
RA7 Extend value of reading, writing, speaking, viewing, and listening by pursuing, through reading, new concepts and interests developed as a result of these activities
RA8 Read extensively from a particular author's work and explain elements of author's style

Subunit: Reading—Multidisciplinary

Competencies:

RM1 Connect themes and ideas across disciplines through literature
RM2 Read to facilitate learning across curriculum
RM3 Read to develop awareness of human rights and freedom
RM4 Participate actively in a community of learners
RM5 Recognize and explain interaction between literature and various cultural domains (e.g., social technological, political, economic)
RM6 Explore and analyze a variety of cultural elements, attitudes, beliefs, and value structures by men and women of many racial, ethnic, and cultural groups
RM7 Value thinking and language of others
RM8 Relate literature to historical period about which or in which it was written
RM9 Read to facilitate content learning

Subunit: Writing—Structure
Competencies:

WS1 Develop and expand a repertoire of organizational strategies (e.g., narration, comparison/contrast, and description) through a practice and discussion
WS2 Clarify word choice according to audience, topic, and purpose
WS3 Locate and correct errors in usage, spelling, and mechanics using a variety of resources
WS4 Recognize information gained from primary and secondary sources
WS5 Develop writing which contains ordered, related, well-developed paragraphs with sentences of varied lengths and patterns
WS6 Use information from a variety of sources to develop an integrated piece of writing
WS7 Evaluate and revise writing to focus on such things as audience, tone, and purpose
WS8 Recognize differences between documentation and reference list styles
WS9 Develop extended pieces of writing which contain ordered, related, well-developed paragraphs with sentences of varied lengths and patterns
WS10 Select from a repertoire of organization strategies a pattern appropriate to a topic
WS11 Synthesize information from a variety of sources
WS12 Refine word choice and tone according to audience, situation, and purpose
WS13 Appropriately cite information gained from primary and secondary sources
WS14 Use style manuals or software to prepare documentation and reference lists
WS15 Develop effectively organized pieces of expository writing containing strong voice, clear thesis, and well-developed ideas
WS16 Identify organization patterns appropriate to writing topic
WS17 Respond to others' suggested revisions to a writing piece

Subunit: Writing—Meaning Construction

Competencies:

WM1	Demonstrate knowledge of the recursive nature of the writing process by applying it appropriately to various topics, situations, and audiences
WM2	Develop criteria for writing evaluation using scoring guides and peer/teacher assistance to clarify meaning
WM3	Respond to others' suggested revisions to a piece of writing
WM4	Use word processing, graphics, and publishing aids to construct meaning in writing
WM5	Engage in self-initiated writing activities
WM6	Incorporate personal criteria with generally accepted standards for writing evaluation
WM7	Evaluate, analyze, and synthesize information for writing
WM8	Evaluate own writing using personal and established scoring criteria
WM9	Assess personal/peer revisions to a writing piece
WM10	Recognize and refine personal writing styles

Subunit: Writing—Application
Competencies:

WA1 Apply appropriate writing techniques suitable for varied writing tasks
WA2 Use sentence-combining techniques to improve syntactic fluency and maturity
WA3 Write in response to prompted and self-selected topics in practical, persuasive, descriptive, narrative, and expository domains
WA4 Develop personal voice in writing
WA5 Consider audience and purpose for writing
WA6 Develop criteria for selection and potential development of topic
WA7 Write in a journal or learning log to clarify personal thinking and knowledge
WA8 Apply an expanding vocabulary gained through writing
WA9 Make judicious use of reference sources (e.g., dictionary, thesaurus, on-lien data base, encyclopedia)
WA10 Demonstrate, an appreciation for aesthetically pleasing language through word choice and style
WA11 Apply revising and editing strategies needed for writing task
WA12 Vary sentence lengths and patterns
WA13 Refine personal voice in writing
WA14 Vary styles and formats for intended purpose and audience
WA15 Apply criteria for selection and development of topic
WA16 Participate in peer review of writing in progress
WA17 Use transitions between sentences, ideas, and paragraphs in writing
WA18 Revise and edit papers extensively in preparation for presentation/publication
WA19 Develop a variety of genres
WA20 Focus writing and tone on such elements as audience, situation, and purpose
WA21 Develop topic fully and appropriately
WA22 Use writing process to clarify personal thinking and knowledge
WA23 Apply appropriate recursive writing process as suggested by writing task and writer's process
WA24 Develop an extended piece of writing
WA25 Revise writing and tone to assure focus on such elements as audience, situation, and purpose
WA26 Use writing process to write reflectively

Subunit: Writing—Multidisciplinary
Competencies:

WM1	Use writing process for learning across curriculum
WM2	Use writing process to demonstrate knowledge of need for human rights and freedom
WM3	Value and apply collaborative skills in writing process
WM4	Write in response to reading, speaking, viewing, and listening
WM5	Use multidisciplinary resources in writing projects
WM6	Use writing process to facilitate learning across curriculum
WM7	Recognize value of and engage in collaboration in writing process
WM8	Use communication processes to develop a published writing piece in collaboration with others
WM9	Record experiences and observations related to content learning
WM10	Apply collaborative skills in writing process
WM11	Write collaboratively with peers
WM12	Use cross-disciplinary resources in writing projects

Subunit: Listening/Visual Literacy—Structure
Competencies:

LS1	Listen to and view a wide variety of genres
LS2	Become aware of an author's style through listening and viewing a variety of works
LS3	Recognize correct and appropriate grammar, diction, and syntax
LS4	Expand vocabulary through listening to and viewing varied media
LS5	Recognize beauty of language
LS6	Enhance recognition of an author's style through listening and viewing a variety of works
LS7	Recognize use and misuse of language in media
LS8	Refine knowledge of style through listening and viewing multiple works by the same author
LS9	Expand and refine grammar, diction, and syntax through listening
LS10	Compare authors' styles through viewing and listening to their works
LS11	Expand knowledge of complex grammar, diction, and syntax issues

Subunit: Listening/Visual Literacy—Meaning Construction Competencies:

LM1 Develop critical thinking skills necessary to evaluate media and assess oral presentations
LM2 Compare new oral texts to past experiences and knowledge in order to enhance comprehension
LM3 Recognize how rhythmic patterns, silence, and cadences enhance quality of speech and literature
LM4 Focus listening and viewing on themes and/or plots
LM5 Gather information from listening and viewing experiences to enhance research
LM6 Use critical thinking skills to evaluate media and oral presentations
LM7 Use prior knowledge and experiences to facilitate comprehension of new oral texts
LM8 Identify rhythmic and time patterns in speech and literature
LM9 Identify and analyze themes and/or plots when listening and viewing
LM10 Use information gathered from listening and viewing experiences to expand research
LM11 Enhance use of critical thinking skills to evaluate media and oral presentations
LM12 Consider prior knowledge and experiences when attempting to understand the meaning of new texts
LM13 Appreciate rhythmic and time patterns of speech and literature
LM14 Select viewing and listening materials to support written text
LM15 Evaluate media and oral presentations analytically and critically
LM16 Organize prior knowledge and experiences to comprehend new texts
LM17 Organize and use viewing and listening materials to support written text

Subunit: Listening/Visual Literacy—Application Competencies:

LA1 Listen attentively during oral reading
LA2 Use media as stimuli for learning and thinking
LA3 Develop knowledge of structure through art, music, and literature
LA4 Use electronic media to enhance and highlight language learning
LA5 Listen and view for entertainment and enjoyment
LA6 Use technology and other media as means of expressing ideas

Subunit: Listening/Visual Literacy—Multidisciplinary
Competencies:

LM1	Facilitate learning across curriculum through critical listening and viewing
LM2	Engage in individual, small-group, and whole-group listening and viewing activities
LM3	Develop language arts (e.g., viewing, listening) projects collaboratively
LM4	Investigate language and cultural differences through listening and viewing activities
LM5	Participate in a community of learners through productive listening

Subunit: Oral Communication—Structure
Competencies:

OS1	Refine oral communication skills
OS2	Demonstrate knowledge of grammar, usage, and syntax when presenting
OS3	Select topics and vocabulary suitable to audience
OS4	Organize notes and ideas for speaking
OS5	Use language imaginatively
OS6	Modulate voice to meaning when interpreting literature orally
OS7	Organize notes and ideas for formal, semiformal and informal presentations of information
OS8	Refine speaking techniques for formal, semiformal, and informal settings
OS9	Develop repertoire of organizational strategies for presenting information orally
OS10	Expand vocabulary to fit topic
OS11	Select topics suitable to audience, situation, and purpose
OS12	Select appropriate strategies when organizing notes and ideas for speaking

Subunit: Oral Communications—Meaning Construction
Competencies:

OM1 Make connections between prior knowledge and new information for oral presentations
OM2 Participate in informal speaking activities
OM3 Use interviewing techniques to gather information
OM4 Communicate orally to entertain and to inform
OM5 Participate in group communication activities
OM6 Take and organize notes when preparing speech/presentation
OM7 Interpret texts orally to illustrate meaning
OM8 Respond to needs of various audiences
OM9 Gather and assess information for speaking
OM10 Communicate orally to inform and persuade
OM11 Prepare and deliver formal speech/presentation
OM12 Participate in a variety of oral interpretations
OM13 Assess needs of audience and adjust language and presentation according to their knowledge
OM14 Analyze and synthesize information for speaking
OM15 Describe effectiveness of literary selection
OM16 Describe topic or idea in order to clarify personal/audience thinking
OM17 Analyze and synthesize information gathered from a variety of sources for speaking
OM18 Describe validity and/or quality of a literary selection and justify selection
OM19 Interpret orally a variety of literature
OM20 Describe topic or idea to clarify meaning for others

Subunit: Oral Communication—Application
Competencies:

OA1 Become proficient at using interviewing techniques
OA2 Give an oral interpretation for a specific audience
OA3 Develop and apply oral communication skills for cooperative/collaborative learning
OA4 Use oral communication for a variety of purposes and audiences (e.g., negotiations, book reviews, rationales)
OA5 Develop and apply decision-making strategies
OA6 Practice interviewing techniques
OA7 Apply interviewing techniques to purposeful interviews
OA8 Focus oral interpretation on a specific audience

Subunit: Oral Communications—Multidisciplinary Competencies:

OM1 Value thinking and language of others
OM2 Develop oral projects collaboratively
OM3 Be involved in individual, small-group, and whole-group language activities
OM4 Participate actively in a community of learners
OM5 Investigate language and cultural differences through oral language activities

Unit: Mathematics Literacy

NOTE: This content was extracted from the 9-12 cluster of Ohio's Model Mathematics Program. Due to statewide initiatives other than Tech Prep, this literacy unit was not altered to meet competency-based criteria. Each literacy unit forms a critical link between academic teachers and members of business, industry, and labor. [See "The TCP Process" for more information.]

Subunit: Numbers and Number Relations

Competencies:

NR1	Compare, order, and determine equivalence of real numbers
NR2	Estimate answers, compute, and solve problems involving real numbers
NR3	Compare and contrast real number system, rational number system, and whole number system
NR4	Extend knowledge to complex number system and develop facility with its operation

Subunit: Measurement

Competencies:

M1	Estimate and use measurements
M2	Understand need for measurement and probability that any measurement is accurate to some designated specification
M3	Understand and apply measurements related to power and work
M4	Understand and apply measurement concepts of distance-rate-time problems and acceleration problems
M5	Use real experiments to investigate elasticity, heat, sound, electricity, magnetism, light, acceleration, velocity, energy, and gravity
M6	Use real-world problem situations involving mass and weight
M7	Use real-world problem situations involving simple harmonic motion
M8	Establish ratios with and without common units
M9	Construct and interpret maps, tables, charts, and graphs as they relate to real-world mathematics
M10	Understand and solve rate-change problems
M11	Understand and solve right triangle relationships as they relate to measurement, specifically to Pythagorean theorem
M12	Graph and interpret ordered pairs
M13	Compute total sales from a variety of items
M14	Comprehend and compute rates of growth or decay
M15	Comprehend, compute, and interpret real problems involving annuities

Subunit: Measurement (continued)

Competencies:

M16	Develop an ability to identify real problems and provide possible solutions
M17	Express and apply different types of measurement scales
M18	Identify area and volume

Subunit: Estimation and Mental Computation

Competencies:

E1	Use estimation to eliminate choices in multiple-choice tests
E2	Use estimation to determine reasonableness of problem situations in a wide variety of applications
E3	Estimate shape of graphs of various functions and algebraic expressions
E4	Use mental computation when computer and calculator are inappropriate

Subunit: Data Analysis and Probability

Competencies:

D1	Organize data into tables, charts, and graphs
D2	Understand and apply measures of central tendency, variability, and correlation
D3	Use curve fitting to predict from data
D4	Use experimental or theoretical probability, as appropriate, to represent and solve problems involving uncertainty
D5	Use computer simulations and random number generators to estimate probabilities
D6	Test hypotheses using appropriate statistics
D7	Read, interpret, and use tables, charts, and graphs to identify patterns, note trends, draw conclusions, and make predictions
D8	Identify probabilities of events involving unbiased objects
D9	Use sampling and recognize its role in statistical claims
D10	Design a statistical experiment to study problem, conduct experiment, and interpret and communicate outcomes
D11	Describe normal curve in general terms and use its properties
D12	Create and interpret discrete probability distributions
D13	Understand concept of random variable
D14	Apply concept of random variable to generate and interpret probability distributions, including binomial, uniform, and chi square

Subunit: Algebra
Competencies:

A1 Describe problem situations by using and relating numerical, symbolic, and graphical representations
A2 Use language and notation of functions in symbolic and graphing settings
A3 Recognize and use equivalent zeros of a function, roots and the solution of an equation in terms of graphical and symbolic representations
A4 Describe and use logic of equivalence in working with equations, inequalities, and functions
A5 Develop graphical techniques of solution for problem situations involving functions
A6 Explore and describe characterizing features of functions
A7 Make arguments and proofs in algebraic settings
A8 Factor difference of two squares
A9 Identify slope, midpoint, and distance
A10 Explore and combine rational functions
A11 Explore factoring techniques
A12 Solve quadratic equations by factoring and formula
A13 Set up and solve linear equations
A14 Solve systems of linear equations with two variables
A15 Describe geometric situations and phenomena using variables, equations, and functions
A16 Describe measures of central tendency, mean, median, mode, and variance algebraically and graphically
A17 Represent inequalities on number line and in coordinate plane
A18 Use coordinate arguments in making geometric proofs
A19 Symbolize transformations of figures and graphs
A20 Explore geometric basis for functions of trigonometry
A21 Graph linear functions
A22 Develop and use vectors to represent direction and magnitude including operations
A23 Use polar and parametric equations to describe, graph, and solve problem situations
A24 Represent sequences and series as functions both algebraically and graphically
A25 Explore recursive functions and procedures using spreadsheets, other computer utilities, and appropriate notions
A26 Describe and solve algebraic situations with matrices
A27 Describe and use inverse relationship between functions including exponential and logarithmic

Subunit: Algebra (continued)
Competencies:

A28 Analyze and describe errors and error sources that can be made when using computers and calculators to solve problems
A29 Decide whether problem situation is best solved using computer, calculator, paper and pencil, or mental arithmetic/estimation techniques
A30 Explore relationships between complex numbers and vectors
A31 Make arguments concerning limits, convergence and divergence in context involving sequences, series, and other types of functions
A32 Represent transformations in plane with matrices
A33 Contrast and compare algebra's of rational, real, and complex numbers with characteristics of a matrix algebra system
A34 Construct polynomial approximations of a function over specified intervals of convergence
A35 Examine complex numbers as zeros of functions
A36 Translate verbal statements into symbolic language
A37 Simplify algebraic expressions
A38 Use laws and exponents (including scientific notation)
A39 Expand and extend idea of vectors and linear algebra to higher dimensional situations
A40 Use the idea of independent basis elements for a vector space and associated fundamental concepts of finite dimensional linear algebra
A41 Develop and communicate arguments about limit situations
A42 Use matrices to describe and apply transformations
A43 Develop and use polar and parametric equations to represent problem situations
A44 Explore proofs by mathematical induction

Subunit: Geometry
Competencies:

G1 Create and interpret drawings of three-dimensional objects
G2 Represent problem situations with geometric models and apply properties of figures
G3 Apply Pythagorean theorem
G4 Demonstrate knowledge of angles and parallel and perpendicular lines
G5 Explore inductive and deductive reasoning through applications to various subject areas
G6 Translate between synthetic and coordinate representations
G7 Identify congruent and similar figures using transformation with computer programs
G8 Deduce properties of figures using transformations and coordinates
G9 Use deductive reasoning
G10 Explore compass and straightedge constructions in context of geometric theorems
G11 Demonstrate knowledge of and ability to use proof
G12 Use variety of proof techniques (e.g., synthetic, transformational, and coordinate)
G13 Use variety of proof formats, including T-proof (i.e., two-column) and paragraph proof
G14 Explore different proof strategies
G15 Investigate different proofs of theorems
G16 Develop knowledge of an axiomatic system
G17 Apply transformations and coordinates in problem solving
G18 Represent problem situations with geometric models and apply properties of figures
G19 Deduce properties of figures using vectors
G20 Analyze properties of Euclidean transformations and relate translations to vectors
G21 Apply vectors in problem solving
G22 Develop further knowledge of axiomatic systems by investigating and comparing various geometry's

Subunit: Patterns, Relations, and Functions
Competencies:

P1	Model real-world phenomena with polynomial and exponential functions
P2	Explore relationship between zeros and intercepts of functions
P3	Translate among tables, algebraic expressions, and graphs of functions
P4	Use graphing calculator or computer to generate graph of a function
P5	Explore relationship between a linear function and its inverse
P6	Describe and use characteristics of polynomial functions in problem-solving situations
P7	Explore conic sections and graph using graphing calculator or computer
P8	Apply trigonometric functions to problem situations involving triangles
P9	Discover relationships between algebraic description, kind, and properties of conic
P10	Explore periodic real-world phenomena using sine and cosine functions
P11	Analyze effects of parameter changes on graphs
P12	Use graphing calculator or computer to graph functions
P13	Develop an knowledge of rational and transcendental functions
P14	Understand connections between trigonometric and circular functions
P15	Use circular functions to model periodic real-world functions
P16	Solve trigonometric equations and verify trigonometric identities
P17	Understand connections between trigonometric, exponential, and logarithmic functions and polar coordinates, complex numbers, and series
P18	Model real-world phenomena with a variety of functions
P19	Graph using polar coordinates
P20	Explore graphs in three dimensions
P21	Explore functions of several variables
P22	Explore recursive functions using spreadsheets and/or programming languages

Unit: Science Literacy

NOTE: This content was extracted from the 9-12 cluster of Ohio's Draft Model Science Program. Due to statewide initiatives other than Tech Prep, this literacy unit was not altered to meet competency-based criteria. Each literacy unit forms a critical link between academic teachers and members of business, industry, and labor. [See "The TCP Process" for more information.]

Subunit: Scientific Inquiry

Competencies:

Q1 Check the appropriateness and accuracy of measures and computations using various strategies (e.g., estimations, unit analysis, determination of significant figures)
Q2 Use ratios, proportions, and probabilities in appropriate problem situations
Q3 Translate information from and represent information in various forms with equal ease (e.g., tables, charts, graphs, diagrams, geometric figures)
Q4 Use existing algebraic formulas and create new ones in appropriate problem-solving situations
Q5 Estimate and justify probabilities of outcomes of familiar situations based on experimentation and other strategies
Q6 Invent apparatus and mechanical tools needed to perform unique tasks in various situations
Q7 Identify, compare, and contrast different modes of inquiry, habits of mind, and attitudes and dispositions
Q8 Design investigations that are safe and ethical (i.e., obtain consent and inform others of potential outcomes, risks and benefits, and show evidence of concern for human health and safety, concern for non-human species)
Q9 Make and read scale drawings, maps, models, and other representations to aid planning and understanding
Q10 Seek elaboration and justification of data and ideas, and reflect on alternative interpretations of the information
Q11 Use appropriate units for counts and measures
Q12 Create and use databases (electronic and other) to collect, organize, and verify data and observations
Q13 Design and conduct investigations with multiple variables
Q14 Communicate the results of investigations clearly in a variety of situations

Subunit: Scientific Inquiry (continued)

Competencies:

Q15 Examine relationships in nature, offer alternative explanations for the observations, and collect evidence that can be used to help judge among explanations

Q16 Trace the development (e.g., history, controversy, and ramifications) of various theories, focusing on supporting evidence and modification with new evidence

Q17 Select, invent, and use tools, including analog and digital instruments, to make and record direct measurements

Q18 Observe and document events and characteristics of complex systems

Q19 Explain the influence of perspective (e.g., spatial, temporal, and social) on observation and subsequent interpretations

Q20 Create multiple representations of the same data using a variety of symbols, descriptive languages, mathematical concepts, and graphic techniques

Q21 Generate testable hypotheses for observations of complex systems and interactions

Q22 Document potentially hazardous conditions and associated risks in selected homes and public areas

Q23 Participate in public debates, relying on documented and verified data to construct and represent a position on scientific issues

Q24 Construct and test models of physical, biological, social, and geological systems

Q25 Read, verify, debate, and, where necessary, refute research published in popular or technical journals of science (e.g., *Discover*, *Omni*, *Popular Mechanics*)

Q26 Explore discrepant events and develop and test explanations of what was observed

Q27 Conduct theory-based research using surveys, observational instruments, and other methods

Q28 Modify personal opinions, interpretations, explanations, and conclusions based on new information

Q29 Analyze error and develop explanations in various domains

Q30 Formulate taxonomic schemes based upon multivariate models that help to explain similarities and differences in form, distribution, behavior, survival, and origin of objects and organisms

Q31 Demonstrate various logical connections between related concepts (e.g., entropy, conservation of energy)

Q32 Account for discrepancies between theories and observations

Q33 Analyze the changes within a system when inputs, outputs, and interactions are altered

Subunit: Scientific Inquiry (continued)
Competencies:

Q34 Create, standardize, and document procedures
Q35 Determine the sources of significant disparities between the predicted and recorded results and change research procedures to minimize disparities
Q36 Research, locate, and propose applications for abstract patterns (e.g., fractals, Fibonacci sequences, string theory, orbitals)
Q37 Recognize and utilize classification systems for particles, elements, compounds, phenomena, organisms, and others for exploring and predicting properties and behaviors
Q38 Suggest and defend alternative experimental designs and data explanations (e.g., sampling, controls, safeguards)
Q39 Recognize and communicate differences between questions that can be investigated in a scientific way and those that rely on other ways of knowing
Q40 Draw conclusions based on the relationships among data analysis, experimental design, and possible models and theories
Q41 Suggest new questions as a result of reflection on and discussions about their own scientific investigations
Q42 Investigate, assess, and comment on strengths and weakness of the descriptive and predictive powers of science
Q43 Create new information from representations of data in a variety of forms (e.g., symbols, descriptive languages, graphic formats) utilizing a variety of techniques (e.g., interpolations, extrapolations, linear regressions, central tendencies, correlation's)

Subunit: Scientific Knowledge
Competencies:

K1 Investigate various types of dynamic equilibrium (e.g., biological, geological, mechanical, chemical)

K2 Investigate the relationship between the rates of energy exchange and the relative energy level of components with systems (e.g., tropic levels of ecosystems, osmosis, rate of heating and cooling, storms)

K3 Investigate patterns in the natural world (e.g., heredity, crystalline structures, population and resource distributions, diffraction, dispersion, polarization)

K4 Investigate models and theories that help to explain the interactions of components in systems (e.g., conservation of mass, energy, and momentum; food webs; natural selection; entropy; plate tectonics; chaos; relativity; social-psychology)

K5 Investigate degrees of kinship among organisms and groups of organisms

K6 Investigate the limits of the definition of life, and investigate organisms and physical systems that exist at or near these limits (e.g. viruses, quarks, black holes)

K7 Investigate estimates and measurements of a wide range of distances and rates of change

K8 Investigate the historical development of theories of change over time (e.g., natural selection, continental drift, the big bang, geologic change)

K9 Investigate physical and chemical changes in living and non-living systems (e.g., photosynthesis, weathering processes, glaciation, thermal effects of materials, energy cells)

K10 Investigate simulations of nuclear change (e.g., radioactivity, half life, carbon dating)

K11 Investigate conservation principles associated with physical, chemical, and nuclear changes

K12 Formulate descriptions of the impacts of various forms of mechanical and electromagnetic waves on various organisms on each other over time

K13 Formulate models and hypotheses for patterns in the natural world (e.g., earth structures, transportation systems, migrations, communications, constellations)

K14 Formulate explanations for the influences of objects and organisms on each other over time

K15 Formulate and interpret explanations for change phenomena (e.g., mass extinction's, stellar evolution, punctuated equilibrium, molecular synthesis)

Subunit: Scientific Knowledge (continued)
Competencies:

K16 Formulate and interpret explanations for the magnitudes of diversity at different periods of geologic time (e.g., mutation, global cataclysms, continental drift, competition, mass extinction's)

K17 Formulate interpretations of the structure, function, and diversity in a variety of organisms and physical systems (e.g., DNA and RNA variants, nucleons, interaction particles)

K18 Formulate understandings of geologic time (e.g., millennia, periods, epochs)

K19 Formulate an understanding of the historical development of the model of the universe

K20 Formulate explanations and representations of the production, transmission, and conservation of energy in biological and physical systems (e.g., weather, volcanism, earthquakes, electricity, magnetism, cellular respiration)

K21 Formulate models and hypotheses about patterns in the natural world (e.g., social behavior, molecular structure, energy transformation, entropy, randomness, aging, chaos, hormonal cycles)

K22 Formulate interpretations of the relationship between energy exchange and the interfaces between components within systems

K23a Formulate estimations for the range of energies within and between various phenomena (e.g., thermal, electromagnetic, thermonuclear, chemical, electrical)

K23b Formulate explanations for the historical development of descriptions of motions interactions and transformations of matter and energy (e.g., classical Newtonian mechanics, special and general relativity, chaos)

K24 Formulate models that can be used to describe fundamental molecular interactions in living and non-living systems (e.g., cell membranes, semiconductors).

K25 Formulate an understanding of the degree of relationship among organisms and objects based on molecular structure (e.g., proteins, nucleic acids)

K26 Formulate hypotheses and models that may account for observable events (e.g., electricity and magnetism, gravitation, atoms, bonding, chemical reactions, quantum effects, energy flow on biological systems, predator-prey relationships)

K27 Formulate models and hypotheses about change over time (e.g., natural selection, speciation, punctuated equilibrium, phyleytic gradualism, stellar evolution, plate tectonics, radioactive decay, quantum mechanical theory)

Subunit: Scientific Knowledge (continued)
Competencies:

K28 Formulate lists of limitations and propose refinements of standard classification systems (e.g., periodic table, IUPAC, Linnean, standard model)

K29 Formulate specific cases of limitations and possible exceptions of theories and principles regarding the interactions of moving objects and organisms (e.g., fluid flow in vessels, motion near the speed of light, Heisenberg uncertainty principle, meteorological prediction, local variation and diversity, predicting earthquakes, energy transport in cellular respiration)

K30 Formulate plans and contingencies that can be used to accommodate for changes to and stresses on systems (e.g., wildlife and habitat management, corrosion prevention, noise abatement, structure design)

K31 Formulate models of molecular, atomic, ionic, and subatomic structures and the physical and biological implications of these structures (e.g., genes, nucleons, quarks)

K32 Formulate estimates for a wide range of measurements and scales (e.g., angstroms to light years)

K33 Formulate and interpret representations of time from origin to present accounting for phenomena of scale (e.g., smoothness, punctuation's, chaos)

K34 Formulate interpretations of the historical development of various theories of possible causes of diversity among physical and biological phenomena (e.g., the works of Aristotle, Mendel, Darwin, McClintock)

K35 Formulate models and hypotheses that can be used to explain the interactions of components within technological and ecological systems

Subunit: Conditions for Learning Science
Competencies:

C1 Participate actively in dialogue about and resolution of community issues

C2 Assess information from various countries in the original language or translated form to ascertain the perspectives of many cultures

C3 Analyze the scientific ideas presented in science fiction stories and films

C4 Perform and repeat investigations to verify data, determine regularity, and reduce the impact of experimental error

C5 Present the results of investigations in a variety of forums

C6 Contribute to the decisions regarding topics for investigation

C7 Use various creative means to communicate interpretations of scientific ideas, concepts, phenomena, and events

C8 Consider the scientific thinking and language of others

C9 Individually and collaboratively produce clearly written representations of investigative results

C10 Fulfill responsibilities as part of a research group

C11 Select and utilize resources by various criteria (e.g., efficiency, effectiveness, health, safety) that are appropriate to the investigations being conducted by groups

C12 Present persuasive argument based on the scientific aspects of controversial issues

C13 Collect, store, retrieve, and manipulate information with available t technologies alleges that may range from hand processes up through computer applications

C14 Investigate social issues with a scientific perspective (e.g., human rights, wellness, economics, futurism, environmental ethics)

C15 Keep journals of observations and inferences made over an extended period of time and reflecting upon the impact of these recorded ideas on their thinking and actions

C16 Examine the intellect, perspectives, and ethics of notable scientists

C17 Collect and analyze observations made over extended periods of time and compare these to scientific theories

C18 Create presentations of scientific understandings using diverse modes of expressions

C19 Conduct formal scientific debates in the classroom

C20 Wonder about the likelihood of events that may occur by chance or coincidence

C21 Plan and conduct field trips and experiences for small and large groups

C22 Analyze the historical context which leads to and has lead to scientific t theories

Subunit: Conditions for Learning Science (continued)
Competencies:

C23 Seek information on topics of personal scientific interest from a variety of sources
C24 Conduct learner-developed investigations independently and collaboratively over periods of week and months
C25 Listen attentively and critically to presentations of scientific information made by others
C26 Conduct analyses of propaganda related to scientific issues
C27 Perform investigations that require observations over varying periods of time
C28 Experience scientific concepts as interpreted by other cultures through multimedia and local and global specialists
C29 Access appropriate technology to perform complicated, time-consuming tasks
C30 Relate historical accounts of science to the cultural context in which they were written
C31 Work as a contributing member of a collaborative research group
C32 Examine the influences of social and political structures and realities that contribute to inquiry about scientific issues
C33 Use technology (e.g., desktop publishing, teleconferencing, networking) to communicate scientific ideas
C34 Explore and analyze a variety of perspectives on science (e.g., works by men and women of many racial, ethnic, and cultural groups)
C35 Lead groups of learners of various ages in designing, planning, and conducting science activities
C36 Respect the scientific thinking of others and self
C37 Recognize and contrast different epistemologies
C38 Develop possible courses of action in response to scientific issues of local and global concern
C39 Determine the validity of research conclusions in relation to the design, performance, and results
C40 Develop multimedia presentations of group and individual research projects and investigations appropriate for a variety of audiences and forums
C41 Produce interesting and scientifically correct stories and present them using various modes of expression
C42 Reflect on the ideas and content found in their own journal records
C43 Examine ambiguous results and formulate explanations
C44 Recognize and synthesize the contributions to scientific thought of individuals from many cultures

Subunit: Conditions for Learning Science (continued)
Competencies:

C45 Construct models and simulations of the component structures and functions of living and non-living entities
C46 Lead multi-age groups in the examination of and planned resolution for scientific issues
C47 Recognize and choose members of research teams based upon the merit of their ideas and skills
C48 Construct a portfolio of products, documentation, and self-evaluations of his/her own abilities, skills, and experiences
C49 Synthesize scientific information from a variety of sources
C50 Evaluate and prioritize scientific issues based upon risk-benefit analyses
C51 Refining scientific skills from a variety of experiences

Subunit: Applications for Science Learning

Competencies:

A1 Answer student-determined questions by designing databases and drawing inferences from the analyses of the information in these data bases

A2 Make personal behavior decisions by interpreting information that has a scientific basis

A3 Propose courses of action that will validate and demonstrate personal understandings of scientific principles

A4 Guide other learners in their understanding of the interactions of technologies and society at various periods in time

A5 Promote and carry out practices that contribute to a sustainable environment

A6 Study and propose improvements in public services and systems in their community

A7 Choose consumer materials utilizing personal and environmental risk and benefit information

A8 Make inferences and draw conclusions using databases, spreadsheets, and other technologies

A9 Do simple trouble-shooting on common electrical and mechanical systems, identifying and eliminating possible causes of malfunctions

A10 Construct devices that perform simple, repetitive actions

A11 Investigate the functionality of various geometric shapes in the natural world and the designed world (e.g., translations from spherical to plane representations cause distortions, triangular shapes contribute to rigidity and stability in structures, round shapes minimize boundary for a given capacity)

A12 Make decisions regarding personal and public health

A13 Evaluate the social and ecological risks and benefits resulting from the use of various consumer products

A14 Analyze the contributions of advances in technology through history to his/her everyday life

A15 Identify and reduce risks and threats to a sustainable environment

A16 Extend the limits of human capabilities using technological enhancements

A17 Use and recognize various propaganda techniques

A18 Solve unique problems using the results of systematic analyses

A19 Choose everyday consumer products that utilize recent innovation and pass appropriate performance criteria

A20 Refine personal career interests through investigations of the diversity of manufacturing, research, service, and invention processes

Subunit: Applications for Science Learning (continued)
Competencies:

A21 Predict and investigate the working of toys and tools while controlling and manipulating variables (e.g., friction, gravity, forces)

A22 Write, follow, modify, and extend instructions (e.g., equations, algorithms, formulas, flow diagrams, illustrations)

A23 Create products, make inferences, and draw conclusions using databases, spreadsheets, and other technologies

A24 Predict various scenarios and propose solutions to community issues using scientific information (e.g., actuarial tables, census data, topographic maps, incidence data, climatic data)

A25 Use scientific evidence to consider options and formulate positions about the health and safety of others and him/herself

A26 Search for, use, create, and store objects and information using various strategies and methods of organization and access

A27 Research and write environmental impact statements of his/her own design

A28 Compare school-based science perspectives with those gained through cutting-edge technological applications

A29 Design management plans for natural and human-altered environments (e.g., woodlots, patios, lots, lawns, farmlands, forests)

A30 Refine personal career interests

A31 Promote public awareness of the interaction of technology with social i issues

A32 Advocate and propose courses of action for local and global scientific issues using global networks

A33 Use appropriate technologies to prepare and present the findings of investigations incorporating tables, graphs, diagrams, and text

A34 Make informed consumer choices by evaluating and prioritizing information, evidence, and strategies

A35 Develop an informed point-of-view that allows for validation or refutation of the scientific statements and claims of advocated before pursuing courses of action (e.g., contributing support, signing petitions, casting votes)

A36 Differentiate between observations and inferences in the exploration of evidence related to personal, scientific, and community issues

A37 Develop and write environmental impact and safety and hygiene management plans

A38 Use technology to collect, analyze, and communicate information (e.g., electronic networks, desktop publishing, remote sensing, graphing calculators, satellite telemetry, and others)

A39 Design, construct, and market inventions

Unit: Technology Literacy

NOTE: Over 500 Ohio business, industry, and labor representatives examined, altered, and then verified the content for this unit during the TCP Process. The original content was extracted from the Report of the Task Force on Technology Competence—Learner Goals for All Minnesotans, published by the Minnesota State Council on Vocational Technical Education. The Technology Literacy unit forms a critical link between all teachers and stresses the importance of technological impact on teaching and learning. [See "The TCP Process" for more information.]

Competencies:

T1 Demonstrate a systems view of technology based on the interdependence of social, political, economic, and ecological systems
T2 Assess the career, family, and personal development implications of technological change
T3 Demonstrate continuous learning via technology
T4 Demonstrate global appreciation for technology's potential effects on cultures, geographic areas, and the environment
T5 Apply historical perspective on technology to the development and use of new technologies
T6 Apply diverse technologies to store, access, process, create, and communicate information needed to solve problems
T7 Apply legal principles and ethical conduct to the use of technology
T8 Demonstrate competency in mathematics, science, social sciences, communication, and computer skills through the analysis, design, and evaluation of technological systems
T9 Analyze the potential of alternative technological systems to solve problems and/or to extend human capabilities
T10 Use a variety of tools, materials, and equipment in solving problems and extending human capabilities
T11 Assess risks and benefits of technological developments from an ecological, economic, social, and political perspective
T12 Value human diversity as part of a team in suggesting, designing, and testing solutions to technological problems

Unit: Employability Skills

Competency: Develop a career plan

Competency Builders:

Identify current interests and aptitudes
Identify common barriers to employment
Describe strategies to overcome employment barriers
Locate resources for finding employment
Research job trends
Identify career options
Identify advantages and disadvantages of career options (in addition to other than monetary)
Identify job requirements
Investigate education/training opportunities
Evaluate personal strengths and weaknesses

Competency: Prepare for employment

Competency Builders:

Identify traditional and non-traditional employment sources
Identify present and future employment opportunities (by geographic location)
Research job opportunities, including non-traditional careers
Compare salary ranges and benefit packages
Compile occupational profile
Identify rights and responsibilities of equal employment opportunity laws
Design resume and cover letter
Target resume
Secure references
Investigate generic and specific employment tests (e.g., civil service exam; drug screening)
Use follow-up techniques to enhance employment potential
Demonstrate legible written communication skills using correct grammar, spelling, punctuation, and concise wording
Describe methods for handling illegal questions on job application forms and during interviews
Write letter of application
Research prospective employer and services performed
Explain critical importance of personal appearance, hygiene, and demeanor
Interpret job description
Demonstrate appropriate interview question and answer techniques
Demonstrate methods for handling difficult interview questions
Evaluate job offers
Write letter of acceptance
Write letter of declination
Demonstrate good listening skills
Ask for the job tactfully
Participate in extracurricular activities (e.g., student government, community projects,)

Competency: Evaluate the importance of self-esteem as an employability skill

Competency Builders:

Identify factors that affect self-esteem
Compare effects of low self-esteem and high self-esteem
Identify strategies to promote positive self-esteem

Competency: Demonstrate job retention skills

Competency Builders:

Identify employer expectations regarding job performance, work habits, attitudes, personal appearance, and hygiene
Exhibit appropriate work habits and attitude
Demonstrate ability to set priorities
Identify behaviors to establish successful working relationships
Identify alternatives for dealing with harassment, bias, and discrimination based on race, color, national origin, sex, religion, handicap, or age
Identify opportunities for advancement
List reasons for termination
List consequences of being absent frequently from job
List consequences of frequently arriving late for work
Demonstrate interpersonal relations skills (i.e., verbal and written)
Demonstrate negotiation skills
Demonstrate teamwork
Follow chain-of-command
Exhibit appropriate job dedication

Competency: Demonstrate knowledge of work ethic

Competency Builders:

Define work ethic
Identify factors that influence work ethic
Differentiate law and ethics
Describe how personal values are reflected in work ethic
Describe how interactions in the workplace affect personal work ethic
Describe how life changes affect personal work ethic

Competency: Exhibit appropriate work ethic

Competency Builders:

Use time-management techniques
Avoid personal activity during work hours
Attend work as scheduled
Adhere to company and/or governmental policies, procedures, rules, and regulations
Exercise confidentiality
Demonstrate appropriate human relations skills
Adhere to rules of conduct
Accept constructive criticism
Offer constructive criticism
Take pride in work
Resolve conflict
Manage stress
Avoid sexual connotations and harassment
Adjust to changes in the workplace
Demonstrate punctuality
Assume responsibility for personal decisions and actions
Take responsibility for assignments
Follow chain-of-command

Competency: Apply decision-making techniques

Competency Builders:

Identify decision to be made
Identify ownership of decision to be made
Identify possible alternatives and their consequences
Make decisions based on facts, legality, ethics, goals, and/or culture
Apply time factor(s)
Present decision to be implemented
Evaluate decision made
Take responsibility for decision

Competency: Apply problem-solving techniques

Competency Builders:

Identify problem
Select appropriate problem solving tools/techniques
Identify root problem cause(s)
Track root problem cause(s)
Identify possible solutions and their consequences (e.g., long term, short term, crisis)
Use resources to explore possible solutions to problem
Contrast advantages and disadvantages of each solution
Identify appropriate action
Evaluate results
Identify post-preventive action

Competency: Exhibit characteristics for job advancement

Competency Builders:

Display positive attitude
Demonstrate knowledge of position
Perform quality work
Adapt to changing situations and technology
Demonstrate capability/responsibility for different positions
Identify characteristics of effective leaders
Identify opportunities for leadership in work place/community
Demonstrate initiative to affect change in workplace
Participate in continuing education/training program
Responds appropriately to criticism from employer, supervisor, or other employees
Exhibit awareness of corporate culture
Prepare for job setbacks
Exhibit continual growth based on performance evaluation
Set realistic goals

Unit: Professionalism

Competency: Project professional image

Competency Builders:

Define professionalism
Exhibit professional appearance
Exhibit professional manners
Project professional attitude
Identify individuals' vital role in organization
Exhibit proper etiquette in professionally-related situations

Competency: Achieve individual and professional goals

Competency Builders:

Set flexible, realistic, and measurable goals
Identify potential barriers to achieving goals
Identify strategies for addressing barriers to goal achievement
Breakdown long-term goals into short-term goals
Prioritize goals
Commit to goals
Adjust goals
Obtain support for goals
Reward goal achievement

Competency: Manage personal finances

Competency Builders:

Explain need for personal management records
Balance checkbook
Identify tax obligations
Analyze how credit affects financial security
Compare types and methods of investments
Compare types and methods of borrowing
Compare types and methods of insurance
Compare types of retirement options/plans
Identify discriminatory vs. non-discriminatory expenditures

Competency: Support community well-being

Competency Builders:

Identify environmental, educational, and social issues
Participate in social and/or community activities

Competency: Achieve organizational goals

Competency Builders:

Evaluate personal goals in relation to organizational goals
Monitor progress by evaluating feedback
List responsibilities in relation to organization goals
Accomplish assigned tasks
Exercise responsibility in relation to organizational goals
Set appropriate personal performance standards
Communicate goals with supervisor and peers
Demonstrate knowledge of products and services
Promote organizational image and mission

Competency: Demonstrate positive relations in the workplace

Competency Builders:

Identify personality types of self and other
Identify various management styles
Support employer expectations
Support employer decisions
Accept constructive criticism
Give constructive feedback
Adapt to changes in workplace
List factors to consider before resigning
Write letter of resignation

Competency: Manage stressful situations

Competency Builders:

Accept stress as part of daily life
Identify personal and professional factors contributing to stress
Describe physical and emotional responses to stress
Evaluate positive and negative effects of stress on productivity
Identify strategies for reducing stress
Implement strategies to manage stress
Create strategies for developing and maintaining support systems

Competency: Analyze effects of family on work and work on family

Competency Builders:

Identify how family values, goals, and priorities are reflected in work place
Identify responsibilities and rewards associated with paid and non-paid work
Identify responsibilities and rewards associated with families
Explain how family responsibilities can conflict with work
Explain how work can conflict with family responsibilities
Explain how work-related stress can affect families
Explain how family-related stress can affect work
Identify family support systems and resources
Identify work-related support systems and resources
Communicate with family regarding work

Competency: Apply lifelong learning skills

Competency Builders:

Define lifelong learning
Identify factors that cause need for lifelong learning
Analyze effects of change
Identify reasons why goals change
Describe importance of flexibility and adaptability
Evaluate need for continuing education/training

Competency: **Manage professional development**

Competency Builders:

Identify career opportunities
Modify career plan
Participate in continuing education/training opportunities
Document continuing education/training
Read profession-related manuals, technical journals, and periodicals
Attend meetings, workshops, seminars, conferences, and demonstrations
Participate in professional organizations
Build personal/professional mentor relationship
Build personal/professional support system
Build professional network
Strengthen communication skills
Strengthen leadership skills
Strengthen management skills

Unit: Teamwork

Competency: Demonstrate knowledge of teamwork

Competency Builders:

Define empowerment
Differentiate work groups and teams
Identify conditions essential to teamwork (e.g., brainstorming)
Explain influence of culture (e.g., corporate, community) on teamwork
Identify appropriate situations for using teams
Define team structures (e.g., cross functional, quality improvement, task force, quality circles)
Identify team building concepts
Describe characteristics and dynamics of teams
Identify characteristics of effective team leaders and members
Identify responsibilities of a valuable team member
Identify methods of involving each member of a team
Explain how individuals from various backgrounds contribute to work-related situations (e.g., technical training, cultural heritage)
Explain the purpose of facilitators
Define consensus
Define reward/recognition system

Competency: Demonstrate teamwork

Competency Builders:

Identify purpose of team and intended goal (include time frames)
Structure team around purpose
Define responsibilities of team members
Contribute to efficiency and success of team
Work toward individual and team milestones
Analyze results of team project
Facilitate a team meeting
Assist team member(s) with problem
Monitor time frame
Stress continuous improvement
Accept failure as part of learning

Competency: Use teamwork to solve problems

Competency Builders:

Identify appropriate situations for using teams
Use problem-solving process in a team setting
Identify quality management processes/techniques
Identify quality assurance processes/techniques
Prepare presentation

Competency: Conduct team meetings

Competency Builders:

Plan agenda
Schedule meeting and location
Invite appropriate personnel
Solicit outside speakers as needed
Assign someone to take minutes
Facilitate introductions
Invite questions and comments and group participation
Focus team on agenda items
Assign appropriate action, time frame and accountability to tasks
Monitor time
Close meeting on time
Publish minutes in timely manner
Set ground rules
Avoid placing individual agendas above the group's agenda

Unit: Quality Assurance

Competency: **Demonstrate knowledge of quality assurance**

Competency Builders:

Explain the historical evolution of quality assurance (e.g., Deming, ISO 9000)
Explain changes brought about by quality leaders in the world
Explain the ISO 9000 process
Define quality terms
Define quality functions
Identify features of quality planning
Describe control devices used in functional areas (e.g., SPC, equipment)
Explain the relationship among organizational structures, policies, procedures, and quality assurance
Explain importance of internal and external customers
Identify internal and external customers
Describe successful efforts by industry to improve quality and/or reduce costs
Differentiate prevention and detection
Differentiate variable and attribute data
Identify types of coontrol charts
Explain how statistical techniques are tools used to control quality (e.g., SPC, DOE, CR)

Competency: **Demonstrate knowledge of quality cost implications**

Competency Builders:

Identify cost/quality objectives
Classify costs (i.e., direct and indirect, fixed and variable, methods and standards)
Classify quality costs (i.e., prevention, evaluation, pre-delivery failure, post-delivery failure)
Define produce liability
Interpret quality cost reports
Explain consumerism and liability prevention
Define safety terms of product
Identify safety responsibility within organization
Define contracts and torts
Differentiate express and implied warranty
Differentiate warranty and product liability
Explain how warranties are part of contract law
List questions that would need answering in liability claim

Competency: **Demonstrate knowledge of engineering a quality product**

Competency Builders:

Associate customer satisfaction with product characteristics (e.g., usefulness, price, operation, life, reliability, safety, cost of operation)
Define manufacturability
Identify steps in product design (e.g., brainstorming, thumbnail sketches, rendering)
Define reliability factors (e.g., cost, human, producibility)
Identify ways reliability is achieved (e.g., maintainability, good design, design simplification, design redundancy)
Explain the relationship of maintainability to reliability
Define failure
Explain the role of testing and reliability
Define value engineering
Define quality objectives
Identify cost components as they relate to quality objectives
Classify quality costs (i.e. preventive, evaluation, pre-delivery failures, post delivery failures)
Describe predictive maintenance

Competency: Explain importance of interdepartmental relationships to quality assurance

Competency Builders:

Explain need for everyone's commitment in assuring quality
Explain phrase "Everyone is a customer/supplier"
Define quality improvement team models
Explain the importance of top management's support of quality
Explain project selection
Explain project implementation
Explain project evaluation
Explain continuing improvement
Describe future trend of experiment design
Describe future trend of predictive maintenance

Competency: Manipulate quality cost data

Competency Builders:

Develop quality cost data
Translate cost reports
Graph quality cost data (e.g., pareto)

Competency: Manipulate cost control data

Competency Builders:

Develop cost control data
Analyze cost control reports
Provide cost control data
Provide advice on "Make or Buy" decisions (including economical lot size decisions)

Competency: Demonstrate knowledge of basic statistics

Competency Builders:

Describe data collection methods
Collect data
Organize data by flow chart
Interpret data by cause and effect diagrams
Define nominal, ordinal, interval, and ratio data
Define mean, median, and mode
Explain significance of standard deviation
Explain normal distribution

Competency: Demonstrate knowledge of scattergrams

Competency Builders:

Construct scattergram
Interpret for positive, negative, or no correlation between X and Y variables
Test for significance between one and five percent
Explain regression analysis

Competency: Demonstrate knowledge of probability theory

Competency Builders:

Define classical probability
Define empirical probability
Calculate probability for outcomes

Competency: Demonstrate knowledge of precontrol

Competency Builders:

Explain uses of precontrol
Calculate precontrol limits
Explain significance of the limits
Plot values on a precontrol chart
Explain "out-of-control" situation
Make decisions on green, yellow and red conditions

Competency: Demonstrate knowledge of process capability

Competency Builders:

Use X, R, USL, and LSL to determine process capability (upper and lower specification limits)
Calculate estimated process standard deviation
Plot right hand and left hand tail of process variation
Compute Z value for percent of probable defect for process
Calculate C_{PK} values that describe process capability
Describe skewed distributions
List probable causes of skewed distribution

Competency: Use quality control charts

Competency Builders:

Identify operational definitions for attribute criteria
Interpret histogram
Interpret scattergrams
Interpret NP chart
Interpret P chart
Interpret flowchart
Interpret cause-and-effect diagram
Construct P (percentage defective) chart for attributes
Plot control limits of P chart and data points
Check chart for out-of-control conditions
Construct an NP (number defective) chart with control limits and data
Construct C (count of defects) and U (number of defects per unit) charts
Check data on C and U charts
Construct flowchart
Construct cause-and-effect chart

Competency: Interpret $\overline{X}$ and R charts

Competency Builders:

Plot percentages for normal distribution
Test distribution for normality
Explain difference between common cause and special cause
Define an "in-control" process
Explain significance of an out-of-control point on $\overline{X}$ or R chart
Identify patterns and trends on control chart
Identify run up and run down
Test for middle third on control chart
Explain significance of middle third on control chart
Explain Rule of Sevens

Competency: **Construct $\bar{X}$ and R charts**

Competency Builders:

Arrange data into statistical sub-groups
Explain importance of random sampling
Compute $\bar{X}$ (i.e., average of values) and R (i.e., range of values in subgroup) within sample
Plot in $\bar{X}$ and R on chart
Construct control chart with $\bar{\bar{X}}$ (grand average) and $\bar{R}$ (average range) calculated
Calculate upper and lower control limits for $\bar{X}$-chart
Calculate upper and lower control limits for R-chart

Competency: **Conduct process improvement studies**

Competency Builders:

Analyze production methods and processes applying statistical process improvement techniques (e.g., SPC, C_{PK})
Identify appropriate statistical techniques for study (e.g., T-tests, F-test, capability, DOEX)
Identify major steps in conducting a study
Define "report" for a study (e.g., goal, objective, study conduct, results, conclusions, discussions)
Integrate results into the total system

Competency: Demonstrate knowledge of JIT

Competency Builders:

Define just-in-time concept (JIT)
Describe various production methodologies (e.g., standard cycle times, routings, standard quantities, multiple-machine tending)
Describe types of inventory control (e.g., Kanban)
Describe importance of flexibility
Differentiate product layout, process layout, fixed position layout, and cellular layout
Differentiate straight-line, U-shaped, S-shaped, convoluted and comb patterns
Describe advantages/disadvantages of layout and patterns
Explain importance of product protection, identification and storage
List methods of identifying products (e.g., labels, bar codes, radio frequency systems and magnetic strip systems)
Describe manual methods of storage and retrieval
Describe automated storage and retrieval systems (ASRS)
Describe automated guided vehicle moving systems (AGVS)

Competency: Apply JIT

Comptency Builders:

Maintain system for physical handling and movement of material in-process and in-storage
Monitor system of physical handling and movement of material in-process and in-storage
Maintain system for physical handling and movement of finished products
Monitor system of physical handling and movement of finished products
Write requests for deviation from specifications
Implement quality control and inspection standards and procedures
Write engineering change notices and rejection reports
Monitor reports of discrepancy or rejects during production process
Conduct quality tests under different environmental conditions

Competency: Demonstrate knowledge of inspection

Competency Builders:

Explain purpose of inspection
Describe scope of inspection
Explain purpose of incoming, ongoing, and final inspections
Explain early detection inspection
Explain how statistical process control (SPC) aids inspection
Define types of nonconformance
Define degrees of nonconformance
Define corrective action
Describe when to 100% inspect
Describe when to sample inspect
Describe methods of testing for material properties (e.g., harness, strength, chemical makeup, flaws, errors in tooling or setup)
Define rework, salvage, and scrap
Describe ethical decisions an inspector may make
Identify purposes of computer-automated inspection
Explain advantages and limitations of automated inspection
Explain disposition of non-conforming material
Explain basic foolproofing concept to build inspection into process (i.e., poka-yoke)
Use checksheets to organize and record inspection results

Competency: Inspect machinery, materials, and products

Competency Builders:

Identify critical material characteristics from specification(s) or drawing(s)
Perform capability studies for machinery and materials acceptance
Identify appropriate acceptance sampling plan
Conduct incoming materials inspection using sampling plan criteria
Identify critical in-process characteristics from specification(s) or drawing(s)
Demonstrate basic metrology skills
Conduct in-process inspection
Identify appropriate inspection reports and follow-up
Gauge R and R (reproducibility and repeatability)
Apply geometric tolerancing
Explain C = O (zero) acceptance plan
Interpret instructions in a control plan

Competency: **Demonstrate knowledge of nondestructive testing**

Competency Builders:

Describe purpose of nondestructive testing
Identify anomalies
Define defects and discontinuities
Identify factors contributing to defects and discontinuities
Describe ultrasonic testing
Describe advantages and limitations of ultrasonic testing
Describe industrial radiography
Compare use of wet and dry particles in magnetic particle inspection
Explain advantages and limitations of penetrant inspection
Describe microwave testing
Describe holographic inspection
Explain choice of most suitable nondestructive test method
Describe eddy-current testing

Unit: Technical Recording and Reporting

Competency: **Demonstrate proficiency in technical recording**

Competency Builders:

Describe various documentation procedures
Interpret specifications or drawings
Observe process
Ask open-ended questions
Record process (e.g., flowchart, step-by-step)
Identify parameters
Record accurate, truthful data
Maintain test logs
Compile cumulative reference notebook/record
Measure appropriate parameters
Draft preventive maintenance and calibration procedures

Competency: **Demonstrate proficiency in technical reporting**

Competency Builders:

Use data books and cross reference/technical manuals
Compose technical memoranda
Identify type of report or format needed
Use appropriate format
Compile relevant data
Design charts and graphs
Analyze data
Draw conclusions
Explain analytical methods used
Outline reports
Write reports
Present reports

Unit: Computer Literacy

Competency: Describe personal computer operations

Competency Builders:

Explain how data is stored in main computer memory
Explain how computer system executes program instruction
Explain computer storage capacity
Explain how data is represented
Describe data storage techniques
Identify types of memory

Competency: Explain information processing cycle

Competency Builders:

Define operating systems (e.g., DOS, OS/2, UNIX, MAC)
Describe computer languages and their use
Describe computer languages and their use
Describe computer languages and their use
Describe difference between data files and program files
Explain PC layout
Explain PC network layout
Explain mini/mainframe network layout
Differentiate hardware and software
Differentiate open from proprietary architecture

Competency: Operate computer hardware

Competency Builders:

Practice proper media handling techniques (e.g., magnetic fields, dust, liquids)
Identify hardware and its use
Use hardware (e.g., mouse, diskettes, drive, modems, touch screen, printers, digitizers, scanners, cables, protection devices)
Keyboard efficiently
Demonstrate basic care of hardware
Explain need for and application of security levels/procedures
Perform basic hardware troubleshooting
Explain hardware addressing techniques

Competency: Use software

Competency Builders:

Define software types and functions
Describe basic disk operations and care
Perform functions necessary to operate software
List advantages and disadvantages of integrated and dedicated software
Operate system software
Operate diagnostic software
Demonstrate basic proficiency in spreadsheet use
Demonstrate basic proficiency in word processing
Demonstrate basic proficiency in database use
Demonstrate basic proficiency in network use
Demonstrate basic proficiency of utility (e.g., WINDOWS, GUI)
Demonstrate basic proficiency in report writing
Demonstrate system commands
Differentiate ethical use/misuse of software
Describe bulletin boards/electronic mail
Apply security levels/procedures while handling sensitive data
Explain data compression techniques
Explain use and deletion of passwords

Unit: Workplace Safety

Competency: Apply general safety precautions

Competency Builders:

Identify local, state, and federal rules and regulations
Identify personal protective wear and equipment
Identify visual controls (e.g., monitors, read outs)
Identify auditory controls
Identify common sense housekeeping
Interpret hazardous materials notices on containers
Use personal protective wear and equipment
Apply workplace safety rules and procedures
Apply personal safety rules and procedures
Apply workplace organization (e.g., housekeeping)
Apply applicable electrical, mechanical, steam, hydraulic and (e.g., pneumatic safety rules and procedures)
Apply fire safety rules and procedures
Apply hazardous wastes rules and procedures
Apply first aid
Locate (MSDS)
Perform lockout and tagout
Recycle scrap metal, chips, shavings, coolants, solvents, trash, and waste materials
Apply common sense housekeeping
Use preventive maintenance checklists

Competency: **Demonstrate knowledge of safety and workplace hazards**

Competency Builders:

Describe corrective procedures for unsafe conditions
Identify types and potential level of workplace hazards (e.g., physical hazards, fire, chemicals, noise, ionizing radiation, ultraviolet, temperature extremes, ergonomics, biological hazards)
Identify safety materials/equipment (e.g., absorbant socks, oil dry)
Interpret Material Safety Data Sheets (MSDS)
Explain purpose(s) of OSHA and NIOSH
Explain purpose(s) of NEC and NFPA
Identify purpose of emergency evacuation routes, master switch and lockout locations, and safety color coding systems
Identify roles of industrial hygienists, safety professionals, occupational physicians, and occupational nurses
Describe methods of evaluating potential hazards (e.g., visual analysis)
Describe methods of correcting potential hazards
Describe various types of toxicity (e.g., chronic, immediate)
Identify need for reporting accidents
Explain precautions required when using toxic or flammable materials
Define confined space and related requirements
Explain how international directives relate to safety

Competency: **Explain purpose of industrial pollution control systems**

Competency Builders:

Describe types of air, water, solid waste, and noise pollution
Explain purpose of air pollution control systems
Explain purpose of water pollution control systems
Explain purpose of solid waste pollution control systems
Explain purpose of noise pollution control systems
Explain basic philosophy of "right to know" legislation
Explain purpose(s) of EPA
Identify "costs" of industrial pollution control (i.e., dollars vs. impact to environment)
Describe ethics of environmental issues

Competency: **Demonstrate knowledge of ergonomics**

Competency Builders:

Define ergonomics
Define risk factor
Define maximum permissible limit (MPL) and action limit (AL) for lifting
Define cumulative trauma disorder (CTD)
Identify susceptibility factors for CTD
Minimize extreme joint movement
Minimize use of excessive muscle force
Minimize repetitive tasks
Minimize mechanical stresses (e.g., sharp edges, heat, cold, hard surfaces, weights, vibration)
Minimize awkward body positions
Explain use of rest pauses
Explain need for mats and footrest for standing jobs
Explain need for appropriate working heights of chairs, stools, workbenches, equipment
Explain need for adequate lighting
Explain use of anthropometric (i.e., centering one's view of everything around man) design

TECH PREP

"GET SERIOUS . . . ABOUT SUCCESS"

Electronics Technician

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—NOTICE—

Each Tech-Prep Competency Profile developed should respond to the labor market demands of your Tech Prep Consortium. Therefore, the following pages should be examined carefully before being selected for use in TCP Part I. **[See "The TCP Process" for more information.]** For example, in some cases the number of units far exceeds the amount of content that can be covered within a 4 + 2 TPAD Program. All the units listed in this section will not necessarily apply to your situation, nor will all the competencies within each unit be appropriate. Note that several units appear within each specific occupation and would need to only appear once if you are compiling a cluster of occupations. **[See "TCP Matrix" and "How to Use the TCP Binder" for more information.]**

Unit: Communications Literacy

NOTE: This content was extracted from the 9-12 cluster of Ohio's Model Language Arts Program. Due to statewide initiatives other than Tech Prep, this literacy unit was not altered to meet competency-based criteria. Each literacy unit forms a critical link between academic teachers and members of business, industry, and labor. [See "The TCP Process" for more information.]

Subunit: Reading—Structure
Competencies:

RS1	Exhibit knowledge of language structure
RS2	Recognize that there may be more than one interpretation of reading selections
RS3	Recognize various literary devices
RS4	Recognize and discuss literary elements
RS5	Develop and use an increasingly sophisticated vocabulary gained through context
RS6	Apply knowledge of language structure to reading
RS7	Explain why there may be more than one interpretation of reading selections
RS8	Recognize effect of literacy devices on meaning
RS9	Analyze author's use of literary elements
RS10	Recognize relationship of structure to meaning
RS11	Describe various interpretations and meaning levels in reading selections
RS12	Characterize author's use of literary devices
RS13	Characterize use of literary techniques
RS14	Critique a variety of literature with regard to plot, dialogue, theme, setting, and characterization
RS15	Apply an expanding vocabulary gained through reading
RS16	Explain various interpretations and meaning levels in reading selections
RS17	Analyze use of literary techniques (e.g., extended metaphor, simile, personification, hyperbole, pun, alliteration)
RS18	Understand use of literary devices (e.g., irony, satire, allegory, onomatopoeia)
RS19	Analyze and synthesize pieces of literature with regard to plot, dialogue, theme, setting, and characterization

Subunit: Reading—Meaning Construction

Competencies:

RM1	Demonstrate ability to recognize appropriate pre-reading strategies
RM2	Describe effectiveness of a reading selection
RM3	Read to clarify personal thinking and knowledge
RM4	Support interpretation of text by locating and citing specific information
RM5	Develop personal response to a variety of literary works
RM6	Recognize diverse literary interpretations
RM7	Engage in self-selected reading activities
RM8	Confirm and extend meaning in reading by researching new concepts and facts
RM9	Self-monitor and apply corrective strategies when communication has been interrupted or lost
RM10	Use features of literary genres to extend meaning
RM11	Assess effectiveness of a selection read
RM12	Use reading as a possible problem-solving strategy to clarify personal thinking and knowledge
RM13	Use knowledge of semantic elements (e.g., figurative language, denotation, connotation, dialect) to clarify meaning when reading
RM14	Predict, recognize, interpret, and analyze themes based on familiarity with author's work
RM15	Compare and contrast literary genres
RM16	Assess validity and quality of selection read
RM17	Clarify meaning when reading
RM18	Compare personal reaction to critical assessment of a literary selection
RM19	Assess validity of diverse literary interpretations
RM20	Use reference books to find, evaluate, and synthesize information
RM21	Identify tone of a literary work
RM22	Critique validity of diverse literary interpretations
RM23	Integrate personal reaction to and critical assessment of a literary selection

Subunit: Reading—Application

Competencies:

RA1	Select and read material for personal enjoyment and information
RA2	Read a variety of complete, unabridged works
RA3	Employ various reading strategies according to purpose
RA4	Participate in selection of books, materials, and topics for literature study groups
RA5	Develop and apply knowledge of the interrelationship of concepts
RA6	Read selections from a variety of styles and formats, recognizing that style and format influence meaning
RA7	Extend value of reading, writing, speaking, viewing, and listening by pursuing, through reading, new concepts and interests developed as a result of these activities
RA8	Read extensively from a particular author's work and explain elements of author's style

Subunit: Reading—Multidisciplinary

Competencies:

RM1	Connect themes and ideas across disciplines through literature
RM2	Read to facilitate learning across curriculum
RM3	Read to develop awareness of human rights and freedom
RM4	Participate actively in a community of learners
RM5	Recognize and explain interaction between literature and various cultural domains (e.g., social technological, political, economic)
RM6	Explore and analyze a variety of cultural elements, attitudes, beliefs, and value structures by men and women of many racial, ethnic, and cultural groups
RM7	Value thinking and language of others
RM8	Relate literature to historical period about which or in which it was written
RM9	Read to facilitate content learning

Subunit: Writing—Structure
Competencies:

WS1 Develop and expand a repertoire of organizational strategies (e.g., narration, comparison/contrast, and description) through a practice and discussion
WS2 Clarify word choice according to audience, topic, and purpose
WS3 Locate and correct errors in usage, spelling, and mechanics using a variety of resources
WS4 Recognize information gained from primary and secondary sources
WS5 Develop writing which contains ordered, related, well-developed paragraphs with sentences of varied lengths and patterns
WS6 Use information from a variety of sources to develop an integrated piece of writing
WS7 Evaluate and revise writing to focus on such things as audience, tone, and purpose
WS8 Recognize differences between documentation and reference list styles
WS9 Develop extended pieces of writing which contain ordered, related, well-developed paragraphs with sentences of varied lengths and patterns
WS10 Select from a repertoire of organization strategies a pattern appropriate to a topic
WS11 Synthesize information from a variety of sources
WS12 Refine word choice and tone according to audience, situation, and purpose
WS13 Appropriately cite information gained from primary and secondary sources
WS14 Use style manuals or software to prepare documentation and reference lists
WS15 Develop effectively organized pieces of expository writing containing strong voice, clear thesis, and well-developed ideas
WS16 Identify organization patterns appropriate to writing topic
WS17 Respond to others' suggested revisions to a writing piece

Subunit: Writing—Meaning Construction
Competencies:

WM1	Demonstrate knowledge of the recursive nature of the writing process by applying it appropriately to various topics, situations, and audiences
WM2	Develop criteria for writing evaluation using scoring guides and peer/teacher assistance to clarify meaning
WM3	Respond to others' suggested revisions to a piece of writing
WM4	Use word processing, graphics, and publishing aids to construct meaning in writing
WM5	Engage in self-initiated writing activities
WM6	Incorporate personal criteria with generally accepted standards for writing evaluation
WM7	Evaluate, analyze, and synthesize information for writing
WM8	Evaluate own writing using personal and established scoring criteria
WM9	Assess personal/peer revisions to a writing piece
WM10	Recognize and refine personal writing styles

Subunit: Writing—Application
Competencies:

WA1	Apply appropriate writing techniques suitable for varied writing tasks
WA2	Use sentence-combining techniques to improve syntactic fluency and maturity
WA3	Write in response to prompted and self-selected topics in practical, persuasive, descriptive, narrative, and expository domains
WA4	Develop personal voice in writing
WA5	Consider audience and purpose for writing
WA6	Develop criteria for selection and potential development of topic
WA7	Write in a journal or learning log to clarify personal thinking and knowledge
WA8	Apply an expanding vocabulary gained through writing
WA9	Make judicious use of reference sources (e.g., dictionary, thesaurus, on-lien data base, encyclopedia)
WA10	Demonstrate, an appreciation for aesthetically pleasing language through word choice and style
WA11	Apply revising and editing strategies needed for writing task
WA12	Vary sentence lengths and patterns
WA13	Refine personal voice in writing
WA14	Vary styles and formats for intended purpose and audience
WA15	Apply criteria for selection and development of topic
WA16	Participate in peer review of writing in progress
WA17	Use transitions between sentences, ideas, and paragraphs in writing
WA18	Revise and edit papers extensively in preparation for presentation/publication
WA19	Develop a variety of genres
WA20	Focus writing and tone on such elements as audience, situation, and purpose
WA21	Develop topic fully and appropriately
WA22	Use writing process to clarify personal thinking and knowledge
WA23	Apply appropriate recursive writing process as suggested by writing task and writer's process
WA24	Develop an extended piece of writing
WA25	Revise writing and tone to assure focus on such elements as audience, situation, and purpose
WA26	Use writing process to write reflectively

Subunit: Writing—Multidisciplinary
Competencies:

WM1	Use writing process for learning across curriculum
WM2	Use writing process to demonstrate knowledge of need for human rights and freedom
WM3	Value and apply collaborative skills in writing process
WM4	Write in response to reading, speaking, viewing, and listening
WM5	Use multidisciplinary resources in writing projects
WM6	Use writing process to facilitate learning across curriculum
WM7	Recognize value of and engage in collaboration in writing process
WM8	Use communication processes to develop a published writing piece in collaboration with others
WM9	Record experiences and observations related to content learning
WM10	Apply collaborative skills in writing process
WM11	Write collaboratively with peers
WM12	Use cross-disciplinary resources in writing projects

Subunit: Listening/Visual Literacy—Structure
Competencies:

LS1	Listen to and view a wide variety of genres
LS2	Become aware of an author's style through listening and viewing a variety of works
LS3	Recognize correct and appropriate grammar, diction, and syntax
LS4	Expand vocabulary through listening to and viewing varied media
LS5	Recognize beauty of language
LS6	Enhance recognition of an author's style through listening and viewing a variety of works
LS7	Recognize use and misuse of language in media
LS8	Refine knowledge of style through listening and viewing multiple works by the same author
LS9	Expand and refine grammar, diction, and syntax through listening
LS10	Compare authors' styles through viewing and listening to their works
LS11	Expand knowledge of complex grammar, diction, and syntax issues

Subunit: Listening/Visual Literacy—Meaning Construction
Competencies:

LM1	Develop critical thinking skills necessary to evaluate media and assess oral presentations
LM2	Compare new oral texts to past experiences and knowledge in order to enhance comprehension
LM3	Recognize how rhythmic patterns, silence, and cadences enhance quality of speech and literature
LM4	Focus listening and viewing on themes and/or plots
LM5	Gather information from listening and viewing experiences to enhance research
LM6	Use critical thinking skills to evaluate media and oral presentations
LM7	Use prior knowledge and experiences to facilitate comprehension of new oral texts
LM8	Identify rhythmic and time patterns in speech and literature
LM9	Identify and analyze themes and/or plots when listening and viewing
LM10	Use information gathered from listening and viewing experiences to expand research
LM11	Enhance use of critical thinking skills to evaluate media and oral presentations
LM12	Consider prior knowledge and experiences when attempting to understand the meaning of new texts
LM13	Appreciate rhythmic and time patterns of speech and literature
LM14	Select viewing and listening materials to support written text
LM15	Evaluate media and oral presentations analytically and critically
LM16	Organize prior knowledge and experiences to comprehend new texts
LM17	Organize and use viewing and listening materials to support written text

Subunit: Listening/Visual Literacy—Application
Competencies:

LA1	Listen attentively during oral reading
LA2	Use media as stimuli for learning and thinking
LA3	Develop knowledge of structure through art, music, and literature
LA4	Use electronic media to enhance and highlight language learning
LA5	Listen and view for entertainment and enjoyment
LA6	Use technology and other media as means of expressing ideas

Subunit: Listening/Visual Literacy—Multidisciplinary
Competencies:

LM1	Facilitate learning across curriculum through critical listening and viewing
LM2	Engage in individual, small-group, and whole-group listening and viewing activities
LM3	Develop language arts (e.g., viewing, listening) projects collaboratively
LM4	Investigate language and cultural differences through listening and viewing activities
LM5	Participate in a community of learners through productive listening

Subunit: Oral Communication—Structure
Competencies:

OS1	Refine oral communication skills
OS2	Demonstrate knowledge of grammar, usage, and syntax when presenting
OS3	Select topics and vocabulary suitable to audience
OS4	Organize notes and ideas for speaking
OS5	Use language imaginatively
OS6	Modulate voice to meaning when interpreting literature orally
OS7	Organize notes and ideas for formal, semiformal and informal presentations of information
OS8	Refine speaking techniques for formal, semiformal, and informal settings
OS9	Develop repertoire of organizational strategies for presenting information orally
OS10	Expand vocabulary to fit topic
OS11	Select topics suitable to audience, situation, and purpose
OS12	Select appropriate strategies when organizing notes and ideas for speaking

Subunit: Oral Communications--Meaning Construction Competencies:

OM1 Make connections between prior knowledge and new information for oral presentations
OM2 Participate in informal speaking activities
OM3 Use interviewing techniques to gather information
OM4 Communicate orally to entertain and to inform
OM5 Participate in group communication activities
OM6 Take and organize notes when preparing speech/presentation
OM7 Interpret texts orally to illustrate meaning
OM8 Respond to needs of various audiences
OM9 Gather and assess information for speaking
OM10 Communicate orally to inform and persuade
OM11 Prepare and deliver formal speech/presentation
OM12 Participate in a variety of oral interpretations
OM13 Assess needs of audience and adjust language and presentation according to their knowledge
OM14 Analyze and synthesize information for speaking
OM15 Describe effectiveness of literary selection
OM16 Describe topic or idea in order to clarify personal/audience thinking
OM17 Analyze and synthesize information gathered from a variety of sources for speaking
OM18 Describe validity and/or quality of a literary selection and justify selection
OM19 Interpret orally a variety of literature
OM20 Describe topic or idea to clarify meaning for others

Subunit: Oral Communication—Application Competencies:

OA1 Become proficient at using interviewing techniques
OA2 Give an oral interpretation for a specific audience
OA3 Develop and apply oral communication skills for cooperative/collaborative learning
OA4 Use oral communication for a variety of purposes and audiences (e.g., negotiations, book reviews, rationales)
OA5 Develop and apply decision-making strategies
OA6 Practice interviewing techniques
OA7 Apply interviewing techniques to purposeful interviews
OA8 Focus oral interpretation on a specific audience

Subunit: Oral Communications—Multidisciplinary Competencies:

OM1	Value thinking and language of others
OM2	Develop oral projects collaboratively
OM3	Be involved in individual, small-group, and whole-group language activities
OM4	Participate actively in a community of learners
OM5	Investigate language and cultural differences through oral language activities

Unit: Mathematics Literacy

NOTE: This content was extracted from the 9-12 cluster of Ohio's Model Mathematics Program. Due to statewide initiatives other than Tech Prep, this literacy unit was not altered to meet competency-based criteria. Each literacy unit forms a critical link between academic teachers and members of business, industry, and labor. [See "The TCP Process" for more information.]

Subunit: Numbers and Number Relations
Competencies:

NR1 Compare, order, and determine equivalence of real numbers
NR2 Estimate answers, compute, and solve problems involving real numbers
NR3 Compare and contrast real number system, rational number system, and whole number system
NR4 Extend knowledge to complex number system and develop facility with its operation

Subunit: Measurement
Competencies:

M1 Estimate and use measurements
M2 Understand need for measurement and probability that any measurement is accurate to some designated specification
M3 Understand and apply measurements related to power and work
M4 Understand and apply measurement concepts of distance-rate-time problems and acceleration problems
M5 Use real experiments to investigate elasticity, heat, sound, electricity, magnetism, light, acceleration, velocity, energy, and gravity
M6 Use real-world problem situations involving mass and weight
M7 Use real-world problem situations involving simple harmonic motion
M8 Establish ratios with and without common units
M9 Construct and interpret maps, tables, charts, and graphs as they relate to real-world mathematics
M10 Understand and solve rate-change problems
M11 Understand and solve right triangle relationships as they relate to measurement, specifically to Pythagorean theorem
M12 Graph and interpret ordered pairs
M13 Compute total sales from a variety of items
M14 Comprehend and compute rates of growth or decay
M15 Comprehend, compute, and interpret real problems involving annuities

Subunit: Measurement (continued)
Competencies:

M16 Develop an ability to identify real problems and provide possible solutions
M17 Express and apply different types of measurement scales
M18 Identify area and volume

Subunit: Estimation and Mental Computation
Competencies:

E1 Use estimation to eliminate choices in multiple-choice tests
E2 Use estimation to determine reasonableness of problem situations in a wide variety of applications
E3 Estimate shape of graphs of various functions and algebraic expressions
E4 Use mental computation when computer and calculator are inappropriate

Subunit: Data Analysis and Probability
Competencies:

D1 Organize data into tables, charts, and graphs
D2 Understand and apply measures of central tendency, variability, and correlation
D3 Use curve fitting to predict from data
D4 Use experimental or theoretical probability, as appropriate, to represent and solve problems involving uncertainty
D5 Use computer simulations and random number generators to estimate probabilities
D6 Test hypotheses using appropriate statistics
D7 Read, interpret, and use tables, charts, and graphs to identify patterns, note trends, draw conclusions, and make predictions
D8 Identify probabilities of events involving unbiased objects
D9 Use sampling and recognize its role in statistical claims
D10 Design a statistical experiment to study problem, conduct experiment, and interpret and communicate outcomes
D11 Describe normal curve in general terms and use its properties
D12 Create and interpret discrete probability distributions
D13 Understand concept of random variable
D14 Apply concept of random variable to generate and interpret probability distributions, including binomial, uniform, and chi square

Subunit: Algebra
Competencies:

A1	Describe problem situations by using and relating numerical, symbolic, and graphical representations
A2	Use language and notation of functions in symbolic and graphing settings
A3	Recognize and use equivalent zeros of a function, roots and the solution of an equation in terms of graphical and symbolic representations
A4	Describe and use logic of equivalence in working with equations, inequalities, and functions
A5	Develop graphical techniques of solution for problem situations involving functions
A6	Explore and describe characterizing features of functions
A7	Make arguments and proofs in algebraic settings
A8	Factor difference of two squares
A9	Identify slope, midpoint, and distance
A10	Explore and combine rational functions
A11	Explore factoring techniques
A12	Solve quadratic equations by factoring and formula
A13	Set up and solve linear equations
A14	Solve systems of linear equations with two variables
A15	Describe geometric situations and phenomena using variables, equations, and functions
A16	Describe measures of central tendency, mean, median, mode, and variance algebraically and graphically
A17	Represent inequalities on number line and in coordinate plane
A18	Use coordinate arguments in making geometric proofs
A19	Symbolize transformations of figures and graphs
A20	Explore geometric basis for functions of trigonometry
A21	Graph linear functions
A22	Develop and use vectors to represent direction and magnitude including operations
A23	Use polar and parametric equations to describe, graph, and solve problem situations
A24	Represent sequences and series as functions both algebraically and graphically
A25	Explore recursive functions and procedures using spreadsheets, other computer utilities, and appropriate notions
A26	Describe and solve algebraic situations with matrices
A27	Describe and use inverse relationship between functions including exponential and logarithmic

Subunit: Algebra (continued)
Competencies:

A28 Analyze and describe errors and error sources that can be made when using computers and calculators to solve problems
A29 Decide whether problem situation is best solved using computer, calculator, paper and pencil, or mental arithmetic/estimation techniques
A30 Explore relationships between complex numbers and vectors
A31 Make arguments concerning limits, convergence and divergence in context involving sequences, series, and other types of functions
A32 Represent transformations in plane with matrices
A33 Contrast and compare algebra's of rational, real, and complex numbers with characteristics of a matrix algebra system
A34 Construct polynomial approximations of a function over specified intervals of convergence
A35 Examine complex numbers as zeros of functions
A36 Translate verbal statements into symbolic language
A37 Simplify algebraic expressions
A38 Use laws and exponents (including scientific notation)
A39 Expand and extend idea of vectors and linear algebra to higher dimensional situations
A40 Use the idea of independent basis elements for a vector space and associated fundamental concepts of finite dimensional linear algebra
A41 Develop and communicate arguments about limit situations
A42 Use matrices to describe and apply transformations
A43 Develop and use polar and parametric equations to represent problem situations
A44 Explore proofs by mathematical induction

Subunit: Geometry
Competencies:

G1 Create and interpret drawings of three-dimensional objects
G2 Represent problem situations with geometric models and apply properties of figures
G3 Apply Pythagorean theorem
G4 Demonstrate knowledge of angles and parallel and perpendicular lines
G5 Explore inductive and deductive reasoning through applications to various subject areas
G6 Translate between synthetic and coordinate representations
G7 Identify congruent and similar figures using transformation with computer programs
G8 Deduce properties of figures using transformations and coordinates
G9 Use deductive reasoning
G10 Explore compass and straightedge constructions in context of geometric theorems
G11 Demonstrate knowledge of and ability to use proof
G12 Use variety of proof techniques (e.g., synthetic, transformational, and coordinate)
G13 Use variety of proof formats, including T-proof (i.e., two-column) and paragraph proof
G14 Explore different proof strategies
G15 Investigate different proofs of theorems
G16 Develop knowledge of an axiomatic system
G17 Apply transformations and coordinates in problem solving
G18 Represent problem situations with geometric models and apply properties of figures
G19 Deduce properties of figures using vectors
G20 Analyze properties of Euclidean transformations and relate translations to vectors
G21 Apply vectors in problem solving
G22 Develop further knowledge of axiomatic systems by investigating and comparing various geometry's

Subunit: Patterns, Relations, and Functions
Competencies:

P1	Model real-world phenomena with polynomial and exponential functions
P2	Explore relationship between zeros and intercepts of functions
P3	Translate among tables, algebraic expressions, and graphs of functions
P4	Use graphing calculator or computer to generate graph of a function
P5	Explore relationship between a linear function and its inverse
P6	Describe and use characteristics of polynomial functions in problem-solving situations
P7	Explore conic sections and graph using graphing calculator or computer
P8	Apply trigonometric functions to problem situations involving triangles
P9	Discover relationships between algebraic description, kind, and properties of conic
P10	Explore periodic real-world phenomena using sine and cosine functions
P11	Analyze effects of parameter changes on graphs
P12	Use graphing calculator or computer to graph functions
P13	Develop an knowledge of rational and transcendental functions
P14	Understand connections between trigonometric and circular functions
P15	Use circular functions to model periodic real-world functions
P16	Solve trigonometric equations and verify trigonometric identities
P17	Understand connections between trigonometric, exponential, and logarithmic functions and polar coordinates, complex numbers, and series
P18	Model real-world phenomena with a variety of functions
P19	Graph using polar coordinates
P20	Explore graphs in three dimensions
P21	Explore functions of several variables
P22	Explore recursive functions using spreadsheets and/or programming languages

Unit: Science Literacy

NOTE: This content was extracted from the 9-12 cluster of Ohio's Draft Model Science Program. Due to statewide initiatives other than Tech Prep, this literacy unit was not altered to meet competency-based criteria. Each literacy unit forms a critical link between academic teachers and members of business, industry, and labor. [See "The TCP Process" for more information.]

Subunit: Scientific Inquiry
Competencies:

Q1 Check the appropriateness and accuracy of measures and computations using various strategies (e.g., estimations, unit analysis, determination of significant figures)
Q2 Use ratios, proportions, and probabilities in appropriate problem situations
Q3 Translate information from and represent information in various forms with equal ease (e.g., tables, charts, graphs, diagrams, geometric figures)
Q4 Use existing algebraic formulas and create new ones in appropriate problem-solving situations
Q5 Estimate and justify probabilities of outcomes of familiar situations based on experimentation and other strategies
Q6 Invent apparatus and mechanical tools needed to perform unique tasks in various situations
Q7 Identify, compare, and contrast different modes of inquiry, habits of mind, and attitudes and dispositions
Q8 Design investigations that are safe and ethical (i.e., obtain consent and inform others of potential outcomes, risks and benefits, and show evidence of concern for human health and safety, concern for non-human species)
Q9 Make and read scale drawings, maps, models, and other representations to aid planning and understanding
Q10 Seek elaboration and justification of data and ideas, and reflect on alternative interpretations of the information
Q11 Use appropriate units for counts and measures
Q12 Create and use databases (electronic and other) to collect, organize, and verify data and observations
Q13 Design and conduct investigations with multiple variables
Q14 Communicate the results of investigations clearly in a variety of situations

Subunit: Scientific Inquiry (continued)
Competencies:

Q15 Examine relationships in nature, offer alternative explanations for the observations, and collect evidence that can be used to help judge among explanations

Q16 Trace the development (e.g., history, controversy, and ramifications) of various theories, focusing on supporting evidence and modification with new evidence

Q17 Select, invent, and use tools, including analog and digital instruments, to make and record direct measurements

Q18 Observe and document events and characteristics of complex systems

Q19 Explain the influence of perspective (e.g., spatial, temporal, and social) on observation and subsequent interpretations

Q20 Create multiple representations of the same data using a variety of symbols, descriptive languages, mathematical concepts, and graphic techniques

Q21 Generate testable hypotheses for observations of complex systems and interactions

Q22 Document potentially hazardous conditions and associated risks in selected homes and public areas

Q23 Participate in public debates, relying on documented and verified data to construct and represent a position on scientific issues

Q24 Construct and test models of physical, biological, social, and geological systems

Q25 Read, verify, debate, and, where necessary, refute research published in popular or technical journals of science (e.g., *Discover*, *Omni*, *Popular Mechanics*)

Q26 Explore discrepant events and develop and test explanations of what was observed

Q27 Conduct theory-based research using surveys, observational instruments, and other methods

Q28 Modify personal opinions, interpretations, explanations, and conclusions based on new information

Q29 Analyze error and develop explanations in various domains

Q30 Formulate taxonomic schemes based upon multivariate models that help to explain similarities and differences in form, distribution, behavior, survival, and origin of objects and organisms

Q31 Demonstrate various logical connections between related concepts (e.g., entropy, conservation of energy)

Q32 Account for discrepancies between theories and observations

Q33 Analyze the changes within a system when inputs, outputs, and interactions are altered

Subunit: Scientific Inquiry (continued)
Competencies:

Q34 Create, standardize, and document procedures

Q35 Determine the sources of significant disparities between the predicted and recorded results and change research procedures to minimize disparities

Q36 Research, locate, and propose applications for abstract patterns (e.g., fractals, Fibonacci sequences, string theory, orbitals)

Q37 Recognize and utilize classification systems for particles, elements, compounds, phenomena, organisms, and others for exploring and predicting properties and behaviors

Q38 Suggest and defend alternative experimental designs and data explanations (e.g., sampling, controls, safeguards)

Q39 Recognize and communicate differences between questions that can be investigated in a scientific way and those that rely on other ways of knowing

Q40 Draw conclusions based on the relationships among data analysis, experimental design, and possible models and theories

Q41 Suggest new questions as a result of reflection on and discussions about their own scientific investigations

Q42 Investigate, assess, and comment on strengths and weakness of the descriptive and predictive powers of science

Q43 Create new information from representations of data in a variety of forms (e.g., symbols, descriptive languages, graphic formats) utilizing a variety of techniques (e.g., interpolations, extrapolations, linear regressions, central tendencies, correlation's)

Subunit: Scientific Knowledge
Competencies:

K1 Investigate various types of dynamic equilibrium (e.g., biological, geological, mechanical, chemical)

K2 Investigate the relationship between the rates of energy exchange and the relative energy level of components with systems (e.g., tropic levels of ecosystems, osmosis, rate of heating and cooling, storms)

K3 Investigate patterns in the natural world (e.g., heredity, crystalline structures, population and resource distributions, diffraction, dispersion, polarization)

K4 Investigate models and theories that help to explain the interactions of components in systems (e.g., conservation of mass, energy, and momentum; food webs; natural selection; entropy; plate tectonics; chaos; relativity; social-psychology)

K5 Investigate degrees of kinship among organisms and groups of organisms

K6 Investigate the limits of the definition of life, and investigate organisms and physical systems that exist at or near these limits (e.g. viruses, quarks, black holes)

K7 Investigate estimates and measurements of a wide range of distances and rates of change

K8 Investigate the historical development of theories of change over time (e.g., natural selection, continental drift, the big bang, geologic change)

K9 Investigate physical and chemical changes in living and non-living systems (e.g., photosynthesis, weathering processes, glaciation, thermal effects of materials, energy cells)

K10 Investigate simulations of nuclear change (e.g., radioactivity, half life, carbon dating)

K11 Investigate conservation principles associated with physical, chemical, and nuclear changes

K12 Formulate descriptions of the impacts of various forms of mechanical and electromagnetic waves on various organisms on each other over time

K13 Formulate models and hypotheses for patterns in the natural world (e.g., earth structures, transportation systems, migrations, communications, constellations)

K14 Formulate explanations for the influences of objects and organisms on each other over time

K15 Formulate and interpret explanations for change phenomena (e.g., mass extinction's, stellar evolution, punctuated equilibrium, molecular synthesis)

Subunit: Scientific Knowledge (continued)
Competencies:

K16 Formulate and interpret explanations for the magnitudes of diversity at different periods of geologic time (e.g., mutation, global cataclysms, continental drift, competition, mass extinction's)

K17 Formulate interpretations of the structure, function, and diversity in a variety of organisms and physical systems (e.g., DNA and RNA variants, nucleons, interaction particles)

K18 Formulate understandings of geologic time (e.g., millennia, periods, epochs)

K19 Formulate an understanding of the historical development of the model of the universe

K20 Formulate explanations and representations of the production, transmission, and conservation of energy in biological and physical systems (e.g., weather, volcanism, earthquakes, electricity, magnetism, cellular respiration)

K21 Formulate models and hypotheses about patterns in the natural world (e.g., social behavior, molecular structure, energy transformation, entropy, randomness, aging, chaos, hormonal cycles)

K22 Formulate interpretations of the relationship between energy exchange and the interfaces between components within systems

K23a Formulate estimations for the range of energies within and between various phenomena (e.g., thermal, electromagnetic, thermonuclear, chemical, electrical)

K23b Formulate explanations for the historical development of descriptions of motions interactions and transformations of matter and energy (e.g., classical Newtonian mechanics, special and general relativity, chaos)

K24 Formulate models that can be used to describe fundamental molecular interactions in living and non-living systems (e.g., cell membranes, semiconductors).

K25 Formulate an understanding of the degree of relationship among organisms and objects based on molecular structure (e.g., proteins, nucleic acids)

K26 Formulate hypotheses and models that may account for observable events (e.g., electricity and magnetism, gravitation, atoms, bonding, chemical reactions, quantum effects, energy flow on biological systems, predator-prey relationships)

K27 Formulate models and hypotheses about change over time (e.g., natural selection, speciation, punctuated equilibrium, phyleytic gradualism, stellar evolution, plate tectonics, radioactive decay, quantum mechanical theory)

Subunit: Scientific Knowledge (continued)
Competencies:

K28 Formulate lists of limitations and propose refinements of standard classification systems (e.g., periodic table, IUPAC, Linnean, standard model)

K29 Formulate specific cases of limitations and possible exceptions of theories and principles regarding the interactions of moving objects and organisms (e.g., fluid flow in vessels, motion near the speed of light, Heisenberg uncertainty principle, meteorological prediction, local variation and diversity, predicting earthquakes, energy transport in cellular respiration)

K30 Formulate plans and contingencies that can be used to accommodate for changes to and stresses on systems (e.g., wildlife and habitat management, corrosion prevention, noise abatement, structure design)

K31 Formulate models of molecular, atomic, ionic, and subatomic structures and the physical and biological implications of these structures (e.g., genes, nucleons, quarks)

K32 Formulate estimates for a wide range of measurements and scales (e.g., angstroms to light years)

K33 Formulate and interpret representations of time from origin to present accounting for phenomena of scale (e.g., smoothness, punctuation's, chaos)

K34 Formulate interpretations of the historical development of various theories of possible causes of diversity among physical and biological phenomena (e.g., the works of Aristotle, Mendel, Darwin, McClintock)

K35 Formulate models and hypotheses that can be used to explain the interactions of components within technological and ecological systems

Subunit: Conditions for Learning Science

Competencies:

C1	Participate actively in dialogue about and resolution of community issues
C2	Assess information from various countries in the original language or translated form to ascertain the perspectives of many cultures
C3	Analyze the scientific ideas presented in science fiction stories and films
C4	Perform and repeat investigations to verify data, determine regularity, and reduce the impact of experimental error
C5	Present the results of investigations in a variety of forums
C6	Contribute to the decisions regarding topics for investigation
C7	Use various creative means to communicate interpretations of scientific ideas, concepts, phenomena, and events
C8	Consider the scientific thinking and language of others
C9	Individually and collaboratively produce clearly written representations of investigative results
C10	Fulfill responsibilities as part of a research group
C11	Select and utilize resources by various criteria (e.g., efficiency, effectiveness, health, safety) that are appropriate to the investigations being conducted by groups
C12	Present persuasive argument based on the scientific aspects of controversial issues
C13	Collect, store, retrieve, and manipulate information with available t technologies alleges that may range from hand processes up through computer applications
C14	Investigate social issues with a scientific perspective (e.g., human rights, wellness, economics, futurism, environmental ethics)
C15	Keep journals of observations and inferences made over an extended period of time and reflecting upon the impact of these recorded ideas on their thinking and actions
C16	Examine the intellect, perspectives, and ethics of notable scientists
C17	Collect and analyze observations made over extended periods of time and compare these to scientific theories
C18	Create presentations of scientific understandings using diverse modes of expressions
C19	Conduct formal scientific debates in the classroom
C20	Wonder about the likelihood of events that may occur by chance or coincidence
C21	Plan and conduct field trips and experiences for small and large groups
C22	Analyze the historical context which leads to and has lead to scientific t theories

Subunit: Conditions for Learning Science (continued)
Competencies:

C23 Seek information on topics of personal scientific interest from a variety of sources
C24 Conduct learner-developed investigations independently and collaboratively over periods of week and months
C25 Listen attentively and critically to presentations of scientific information made by others
C26 Conduct analyses of propaganda related to scientific issues
C27 Perform investigations that require observations over varying periods of time
C28 Experience scientific concepts as interpreted by other cultures through multimedia and local and global specialists
C29 Access appropriate technology to perform complicated, time-consuming tasks
C30 Relate historical accounts of science to the cultural context in which they were written
C31 Work as a contributing member of a collaborative research group
C32 Examine the influences of social and political structures and realities that contribute to inquiry about scientific issues
C33 Use technology (e.g., desktop publishing, teleconferencing, networking) to communicate scientific ideas
C34 Explore and analyze a variety of perspectives on science (e.g., works by men and women of many racial, ethnic, and cultural groups)
C35 Lead groups of learners of various ages in designing, planning, and conducting science activities
C36 Respect the scientific thinking of others and self
C37 Recognize and contrast different epistemologies
C38 Develop possible courses of action in response to scientific issues of local and global concern
C39 Determine the validity of research conclusions in relation to the design, performance, and results
C40 Develop multimedia presentations of group and individual research projects and investigations appropriate for a variety of audiences and forums
C41 Produce interesting and scientifically correct stories and present them using various modes of expression
C42 Reflect on the ideas and content found in their own journal records
C43 Examine ambiguous results and formulate explanations
C44 Recognize and synthesize the contributions to scientific thought of individuals from many cultures

Subunit: Conditions for Learning Science (continued)
Competencies:

C45 Construct models and simulations of the component structures and functions of living and non-living entities

C46 Lead multi-age groups in the examination of and planned resolution for scientific issues

C47 Recognize and choose members of research teams based upon the merit of their ideas and skills

C48 Construct a portfolio of products, documentation, and self-evaluations of his/her own abilities, skills, and experiences

C49 Synthesize scientific information from a variety of sources

C50 Evaluate and prioritize scientific issues based upon risk-benefit analyses

C51 Refining scientific skills from a variety of experiences

Subunit: Applications for Science Learning
Competencies:

A1 Answer student-determined questions by designing databases and drawing inferences from the analyses of the information in these data bases

A2 Make personal behavior decisions by interpreting information that has a scientific basis

A3 Propose courses of action that will validate and demonstrate personal understandings of scientific principles

A4 Guide other learners in their understanding of the interactions of technologies and society at various periods in time

A5 Promote and carry out practices that contribute to a sustainable environment

A6 Study and propose improvements in public services and systems in their community

A7 Choose consumer materials utilizing personal and environmental risk and benefit information

A8 Make inferences and draw conclusions using databases, spreadsheets, and other technologies

A9 Do simple trouble-shooting on common electrical and mechanical systems, identifying and eliminating possible causes of malfunctions

A10 Construct devices that perform simple, repetitive actions

A11 Investigate the functionality of various geometric shapes in the natural world and the designed world (e.g., translations from spherical to plane representations cause distortions, triangular shapes contribute to rigidity and stability in structures, round shapes minimize boundary for a given capacity)

A12 Make decisions regarding personal and public health

A13 Evaluate the social and ecological risks and benefits resulting from the use of various consumer products

A14 Analyze the contributions of advances in technology through history to his/her everyday life

A15 Identify and reduce risks and threats to a sustainable environment

A16 Extend the limits of human capabilities using technological enhancements

A17 Use and recognize various propaganda techniques

A18 Solve unique problems using the results of systematic analyses

A19 Choose everyday consumer products that utilize recent innovation and pass appropriate performance criteria

A20 Refine personal career interests through investigations of the diversity of manufacturing, research, service, and invention processes

Subunit: Applications for Science Learning (continued)
Competencies:

A21 Predict and investigate the working of toys and tools while controlling and manipulating variables (e.g., friction, gravity, forces)

A22 Write, follow, modify, and extend instructions (e.g., equations, algorithms, formulas, flow diagrams, illustrations)

A23 Create products, make inferences, and draw conclusions using databases, spreadsheets, and other technologies

A24 Predict various scenarios and propose solutions to community issues using scientific information (e.g., actuarial tables, census data, topographic maps, incidence data, climatic data)

A25 Use scientific evidence to consider options and formulate positions about the health and safety of others and him/herself

A26 Search for, use, create, and store objects and information using various strategies and methods of organization and access

A27 Research and write environmental impact statements of his/her own design

A28 Compare school-based science perspectives with those gained through cutting-edge technological applications

A29 Design management plans for natural and human-altered environments (e.g., woodlots, patios, lots, lawns, farmlands, forests)

A30 Refine personal career interests

A31 Promote public awareness of the interaction of technology with social i issues

A32 Advocate and propose courses of action for local and global scientific issues using global networks

A33 Use appropriate technologies to prepare and present the findings of investigations incorporating tables, graphs, diagrams, and text

A34 Make informed consumer choices by evaluating and prioritizing information, evidence, and strategies

A35 Develop an informed point-of-view that allows for validation or refutation of the scientific statements and claims of advocated before pursuing courses of action (e.g., contributing support, signing petitions, casting votes)

A36 Differentiate between observations and inferences in the exploration of evidence related to personal, scientific, and community issues

A37 Develop and write environmental impact and safety and hygiene management plans

A38 Use technology to collect, analyze, and communicate information (e.g., electronic networks, desktop publishing, remote sensing, graphing calculators, satellite telemetry, and others)

A39 Design, construct, and market inventions

Unit: Technology Literacy

NOTE: Over 500 Ohio business, industry, and labor representatives examined, altered, and then verified the content for this unit during the TCP Process. The original content was extracted from the Report of the Task Force on Technology Competence—Learner Goals for All Minnesotans, published by the Minnesota State Council on Vocational Technical Education. The Technology Literacy unit forms a critical link between all teachers and stresses the importance of technological impact on teaching and learning. [See "The TCP Process" for more information.]

Competencies:

T1 Demonstrate a systems view of technology based on the interdependence of social, political, economic, and ecological systems
T2 Assess the career, family, and personal development implications of technological change
T3 Demonstrate continuous learning via technology
T4 Demonstrate global appreciation for technology's potential effects on cultures, geographic areas, and the environment
T5 Apply historical perspective on technology to the development and use of new technologies
T6 Apply diverse technologies to store, access, process, create, and communicate information needed to solve problems
T7 Apply legal principles and ethical conduct to the use of technology
T8 Demonstrate competency in mathematics, science, social sciences, communication, and computer skills through the analysis, design, and evaluation of technological systems
T9 Analyze the potential of alternative technological systems to solve problems and/or to extend human capabilities
T10 Use a variety of tools, materials, and equipment in solving problems and extending human capabilities
T11 Assess risks and benefits of technological developments from an ecological, economic, social, and political perspective
T12 Value human diversity as part of a team in suggesting, designing, and testing solutions to technological problems

Unit: Employability Skills

Competency: Develop a career plan

Competency Builders:

Identify current interests and aptitudes
Identify common barriers to employment
Describe strategies to overcome employment barriers
Locate resources for finding employment
Research job trends
Identify career options
Identify advantages and disadvantages of career options (in addition to other than monetary)
Identify job requirements
Investigate education/training opportunities
Evaluate personal strengths and weaknesses

Competency: Prepare for employment

Competency Builders:

Identify traditional and non-traditional employment sources
Identify present and future employment opportunities (by geographic location)
Research job opportunities, including non-traditional careers
Compare salary ranges and benefit packages
Compile occupational profile
Identify rights and responsibilities of equal employment opportunity laws
Design resume and cover letter
Target resume
Secure references
Investigate generic and specific employment tests (e.g., civil service exam; drug screening)
Use follow-up techniques to enhance employment potential
Demonstrate legible written communication skills using correct grammar, spelling, punctuation, and concise wording
Describe methods for handling illegal questions on job application forms and during interviews
Write letter of application
Research prospective employer and services performed
Explain critical importance of personal appearance, hygiene, and demeanor
Interpret job description
Demonstrate appropriate interview question and answer techniques
Demonstrate methods for handling difficult interview questions
Evaluate job offers
Write letter of acceptance
Write letter of declination
Demonstrate good listening skills
Ask for the job tactfully
Participate in extracurricular activities (e.g., student government, community projects,)

Competency: Evaluate the importance of self-esteem as an employability skill

Competency Builders:

Identify factors that affect self-esteem
Compare effects of low self-esteem and high self-esteem
Identify strategies to promote positive self-esteem

Competency: Demonstrate job retention skills

Competency Builders:

Identify employer expectations regarding job performance, work habits, attitudes, personal appearance, and hygiene
Exhibit appropriate work habits and attitude
Demonstrate ability to set priorities
Identify behaviors to establish successful working relationships
Identify alternatives for dealing with harassment, bias, and discrimination based on race, color, national origin, sex, religion, handicap, or age
Identify opportunities for advancement
List reasons for termination
List consequences of being absent frequently from job
List consequences of frequently arriving late for work
Demonstrate interpersonal relations skills (i.e., verbal and written)
Demonstrate negotiation skills
Demonstrate teamwork
Follow chain-of-command
Exhibit appropriate job dedication

Competency: Demonstrate knowledge of work ethic

Competency Builders:

Define work ethic
Identify factors that influence work ethic
Differentiate law and ethics
Describe how personal values are reflected in work ethic
Describe how interactions in the workplace affect personal work ethic
Describe how life changes affect personal work ethic

Competency: Exhibit appropriate work ethic

Competency Builders:

Use time-management techniques
Avoid personal activity during work hours
Attend work as scheduled
Adhere to company and/or governmental policies, procedures, rules, and regulations
Exercise confidentiality
Demonstrate appropriate human relations skills
Adhere to rules of conduct
Accept constructive criticism
Offer constructive criticism
Take pride in work
Resolve conflict
Manage stress
Avoid sexual connotations and harassment
Adjust to changes in the workplace
Demonstrate punctuality
Assume responsibility for personal decisions and actions
Take responsibility for assignments
Follow chain-of-command

Competency: Apply decision-making techniques

Competency Builders:

Identify decision to be made
Identify ownership of decision to be made
Identify possible alternatives and their consequences
Make decisions based on facts, legality, ethics, goals, and/or culture
Apply time factor(s)
Present decision to be implemented
Evaluate decision made
Take responsibility for decision

Competency: Apply problem-solving techniques

Competency Builders:

Identify problem
Select appropriate problem solving tools/techniques
Identify root problem cause(s)
Track root problem cause(s)
Identify possible solutions and their consequences (e.g., long term, short term, crisis)
Use resources to explore possible solutions to problem
Contrast advantages and disadvantages of each solution
Identify appropriate action
Evaluate results
Identify post-preventive action

Competency: Exhibit characteristics for job advancement

Competency Builders:

Display positive attitude
Demonstrate knowledge of position
Perform quality work
Adapt to changing situations and technology
Demonstrate capability/responsibility for different positions
Identify characteristics of effective leaders
Identify opportunities for leadership in work place/community
Demonstrate initiative to affect change in workplace
Participate in continuing education/training program
Responds appropriately to criticism from employer, supervisor, or other employees
Exhibit awareness of corporate culture
Prepare for job setbacks
Exhibit continual growth based on performance evaluation
Set realistic goals

Unit: Professionalism

Competency: Project professional image

Competency Builders:

Define professionalism
Exhibit professional appearance
Exhibit professional manners
Project professional attitude
Identify individuals' vital role in organization
Exhibit proper etiquette in professionally-related situations

Competency: Achieve individual and professional goals

Competency Builders:

Set flexible, realistic, and measurable goals
Identify potential barriers to achieving goals
Identify strategies for addressing barriers to goal achievement
Breakdown long-term goals into short-term goals
Prioritize goals
Commit to goals
Adjust goals
Obtain support for goals
Reward goal achievement

Competency: Manage personal finances

Competency Builders:

Explain need for personal management records
Balance checkbook
Identify tax obligations
Analyze how credit affects financial security
Compare types and methods of investments
Compare types and methods of borrowing
Compare types and methods of insurance
Compare types of retirement options/plans
Identify discriminatory vs. non-discriminatory expenditures

Competency: Support community well-being

Competency Builders:

Identify environmental, educational, and social issues
Participate in social and/or community activities

Competency: Achieve organizational goals

Competency Builders:

Evaluate personal goals in relation to organizational goals
Monitor progress by evaluating feedback
List responsibilities in relation to organization goals
Accomplish assigned tasks
Exercise responsibility in relation to organizational goals
Set appropriate personal performance standards
Communicate goals with supervisor and peers
Demonstrate knowledge of products and services
Promote organizational image and mission

Competency: Demonstrate positive relations in the workplace

Competency Builders:

Identify personality types of self and other
Identify various management styles
Support employer expectations
Support employer decisions
Accept constructive criticism
Give constructive feedback
Adapt to changes in workplace
List factors to consider before resigning
Write letter of resignation

Competency: Manage stressful situations

Competency Builders:

Accept stress as part of daily life
Identify personal and professional factors contributing to stress
Describe physical and emotional responses to stress
Evaluate positive and negative effects of stress on productivity
Identify strategies for reducing stress
Implement strategies to manage stress
Create strategies for developing and maintaining support systems

Competency: Analyze effects of family on work and work on family

Competency Builders:

Identify how family values, goals, and priorities are reflected in work place
Identify responsibilities and rewards associated with paid and non-paid work
Identify responsibilities and rewards associated with families
Explain how family responsibilities can conflict with work
Explain how work can conflict with family responsibilities
Explain how work-related stress can affect families
Explain how family-related stress can affect work
Identify family support systems and resources
Identify work-related support systems and resources
Communicate with family regarding work

Competency: Apply lifelong learning skills

Competency Builders:

Define lifelong learning
Identify factors that cause need for lifelong learning
Analyze effects of change
Identify reasons why goals change
Describe importance of flexibility and adaptability
Evaluate need for continuing education/training

Competency: Manage professional development

Competency Builders:

Identify career opportunities
Modify career plan
Participate in continuing education/training opportunities
Document continuing education/training
Read profession-related manuals, technical journals, and periodicals
Attend meetings, workshops, seminars, conferences, and demonstrations
Participate in professional organizations
Build personal/professional mentor relationship
Build personal/professional support system
Build professional network
Strengthen communication skills
Strengthen leadership skills
Strengthen management skills

Unit: Teamwork

Competency: Demonstrate knowledge of teamwork

Competency Builders:

Define empowerment
Differentiate work groups and teams
Identify conditions essential to teamwork (e.g., brainstorming)
Explain influence of culture (e.g., corporate, community) on teamwork
Identify appropriate situations for using teams
Define team structures (e.g., cross functional, quality improvement, task force, quality circles)
Identify team building concepts
Describe characteristics and dynamics of teams
Identify characteristics of effective team leaders and members
Identify responsibilities of a valuable team member
Identify methods of involving each member of a team
Explain how individuals from various backgrounds contribute to work-related situations (e.g., technical training, cultural heritage)
Explain the purpose of facilitators
Define consensus
Define reward/recognition system

Competency: Demonstrate teamwork

Competency Builders:

Identify purpose of team and intended goal (include time frames)
Structure team around purpose
Define responsibilities of team members
Contribute to efficiency and success of team
Work toward individual and team milestones
Analyze results of team project
Facilitate a team meeting
Assist team member(s) with problem
Monitor time frame
Stress continuous improvement
Accept failure as part of learning

Competency: Use teamwork to solve problems

Competency Builders:

Identify appropriate situations for using teams
Use problem-solving process in a team setting
Identify quality management processes/techniques
Identify quality assurance processes/techniques
Prepare presentation

Competency: Conduct team meetings

Competency Builders:

Plan agenda
Schedule meeting and location
Invite appropriate personnel
Solicit outside speakers as needed
Assign someone to take minutes
Facilitate introductions
Invite questions and comments and group participation
Focus team on agenda items
Assign appropriate action, time frame and accountability to tasks
Monitor time
Close meeting on time
Publish minutes in timely manner
Set ground rules
Avoid placing individual agendas above the group's agenda

Unit: Quality Assurance

Competency: Demonstrate knowledge of quality assurance

Competency Builders:

Explain the historical evolution of quality assurance (e.g., Deming, ISO 9000)
Explain changes brought about by quality leaders in the world
Explain the ISO 9000 process
Define quality terms
Define quality functions
Identify features of quality planning
Describe control devices used in functional areas (e.g., SPC, equipment)
Explain the relationship among organizational structures, policies, procedures, and quality assurance
Explain importance of internal and external customers
Identify internal and external customers
Describe successful efforts by industry to improve quality and/or reduce costs
Differentiate prevention and detection
Differentiate variable and attribute data
Identify types of coontrol charts
Explain how statistical techniques are tools used to control quality (e.g., SPC, DOE, CR)

Competency: **Demonstrate knowledge of quality cost implications**

Competency Builders:

Identify cost/quality objectives
Classify costs (i.e., direct and indirect, fixed and variable, methods and standards)
Classify quality costs (i.e., prevention, evaluation, pre-delivery failure, post-delivery failure)
Define produce liability
Interpret quality cost reports
Explain consumerism and liability prevention
Define safety terms of product
Identify safety responsibility within organization
Define contracts and torts
Differentiate express and implied warranty
Differentiate warranty and product liability
Explain how warranties are part of contract law
List questions that would need answering in liability claim

Competency: **Demonstrate knowledge of engineering a quality product**

Competency Builders:

Associate customer satisfaction with product characteristics (e.g., usefulness, price, operation, life, reliability, safety, cost of operation)
Define manufacturability
Identify steps in product design (e.g., brainstorming, thumbnail sketches, rendering)
Define reliability factors (e.g., cost, human, producibility)
Identify ways reliability is achieved (e.g., maintainability, good design, design simplification, design redundancy)
Explain the relationship of maintainability to reliability
Define failure
Explain the role of testing and reliability
Define value engineering
Define quality objectives
Identify cost components as they relate to quality objectives
Classify quality costs (i.e. preventive, evaluation, pre-delivery failures, post delivery failures)
Describe predictive maintenance

Competency: Explain importance of interdepartmental relationships to quality assurance

Competency Builders:

Explain need for everyone's commitment in assuring quality
Explain phrase "Everyone is a customer/supplier"
Define quality improvement team models
Explain the importance of top management's support of quality
Explain project selection
Explain project implementation
Explain project evaluation
Explain continuing improvement
Describe future trend of experiment design
Describe future trend of predictive maintenance

Competency: Manipulate quality cost data

Competency Builders:

Develop quality cost data
Translate cost reports
Graph quality cost data (e.g., pareto)

Competency: Manipulate cost control data

Competency Builders:

Develop cost control data
Analyze cost control reports
Provide cost control data
Provide advice on "Make or Buy" decisions (including economical lot size decisions)

Competency: Demonstrate knowledge of basic statistics

Competency Builders:

Describe data collection methods
Collect data
Organize data by flow chart
Interpret data by cause and effect diagrams
Define nominal, ordinal, interval, and ratio data
Define mean, median, and mode
Explain significance of standard deviation
Explain normal distribution

Competency: Demonstrate knowledge of scattergrams

Competency Builders:

Construct scattergram
Interpret for positive, negative, or no correlation between X and Y variables
Test for significance between one and five percent
Explain regression analysis

Competency: Demonstrate knowledge of probability theory

Competency Builders:

Define classical probability
Define empirical probability
Calculate probability for outcomes

Competency: Demonstrate knowledge of precontrol

Competency Builders:

Explain uses of precontrol
Calculate precontrol limits
Explain significance of the limits
Plot values on a precontrol chart
Explain "out-of-control" situation
Make decisions on green, yellow and red conditions

Competency: Demonstrate knowledge of process capability

Competency Builders:

Use X, R, USL, and LSL to determine process capability (upper and lower specification limits)
Calculate estimated process standard deviation
Plot right hand and left hand tail of process variation
Compute Z value for percent of probable defect for process
Calculate C_{PK} values that describe process capability
Describe skewed distributions
List probable causes of skewed distribution

Competency: Use quality control charts

Competency Builders:

Identify operational definitions for attribute criteria
Interpret histogram
Interpret scattergrams
Interpret NP chart
Interpret P chart
Interpret flowchart
Interpret cause-and-effect diagram
Construct P (percentage defective) chart for attributes
Plot control limits of P chart and data points
Check chart for out-of-control conditions
Construct an NP (number defective) chart with control limits and data
Construct C (count of defects) and U (number of defects per unit) charts
Check data on C and U charts
Construct flowchart
Construct cause-and-effect chart

Competency: Interpret $\overline{X}$ and R charts

Competency Builders:

Plot percentages for normal distribution
Test distribution for normality
Explain difference between common cause and special cause
Define an "in-control" process
Explain significance of an out-of-control point on $\overline{X}$ or R chart
Identify patterns and trends on control chart
Identify run up and run down
Test for middle third on control chart
Explain significance of middle third on control chart
Explain Rule of Sevens

Competency: Construct $\bar{X}$ and R charts

Competency Builders:

Arrange data into statistical sub-groups
Explain importance of random sampling
Compute $\bar{X}$ (i.e., average of values) and R (i.e., range of values in subgroup) within sample
Plot in $\bar{X}$ and R on chart
Construct control chart with $\bar{\bar{X}}$ (grand average) and $\bar{R}$ (average range) calculated
Calculate upper and lower control limits for $\bar{X}$-chart
Calculate upper and lower control limits for R-chart

Competency: Conduct process improvement studies

Competency Builders:

Analyze production methods and processes applying statistical process improvement techniques (e.g., SPC, C_{PK})
Identify appropriate statistical techniques for study (e.g., T-tests, F-test, capability, DOEX)
Identify major steps in conducting a study
Define "report" for a study (e.g., goal, objective, study conduct, results, conclusions, discussions)
Integrate results into the total system

Competency: Demonstrate knowledge of JIT

Competency Builders:

Define just-in-time concept (JIT)
Describe various production methodologies (e.g., standard cycle times, routings, standard quantities, multiple-machine tending)
Describe types of inventory control (e.g., Kanban)
Describe importance of flexibility
Differentiate product layout, process layout, fixed position layout, and cellular layout
Differentiate straight-line, U-shaped, S-shaped, convoluted and comb patterns
Describe advantages/disadvantages of layout and patterns
Explain importance of product protection, identification and storage
List methods of identifying products (e.g., labels, bar codes, radio frequency systems and magnetic strip systems)
Describe manual methods of storage and retrieval
Describe automated storage and retrieval systems (ASRS)
Describe automated guided vehicle moving systems (AGVS)

Competency: Apply JIT

Comptency Builders:

Maintain system for physical handling and movement of material in-process and in-storage
Monitor system of physical handling and movement of material in-process and in-storage
Maintain system for physical handling and movement of finished products
Monitor system of physical handling and movement of finished products
Write requests for deviation from specifications
Implement quality control and inspection standards and procedures
Write engineering change notices and rejection reports
Monitor reports of discrepancy or rejects during production process
Conduct quality tests under different environmental conditions

Competency: **Demonstrate knowledge of inspection**

Competency Builders:

Explain purpose of inspection
Describe scope of inspection
Explain purpose of incoming, ongoing, and final inspections
Explain early detection inspection
Explain how statistical process control (SPC) aids inspection
Define types of nonconformance
Define degrees of nonconformance
Define corrective action
Describe when to 100% inspect
Describe when to sample inspect
Describe methods of testing for material properties (e.g., harness, strength, chemical makeup, flaws, errors in tooling or setup)
Define rework, salvage, and scrap
Describe ethical decisions an inspector may make
Identify purposes of computer-automated inspection
Explain advantages and limitations of automated inspection
Explain disposition of non-conforming material
Explain basic foolproofing concept to build inspection into process (i.e., poka-yoke)
Use checksheets to organize and record inspection results

Competency: **Inspect machinery, materials, and products**

Competency Builders:

Identify critical material characteristics from specification(s) or drawing(s)
Perform capability studies for machinery and materials acceptance
Identify appropriate acceptance sampling plan
Conduct incoming materials inspection using sampling plan criteria
Identify critical in-process characteristics from specification(s) or drawing(s)
Demonstrate basic metrology skills
Conduct in-process inspection
Identify appropriate inspection reports and follow-up
Gauge R and R (reproducibility and repeatability)
Apply geometric tolerancing
Explain C = O (zero) acceptance plan
Interpret instructions in a control plan

Competency: Demonstrate knowledge of nondestructive testing

Competency Builders:

Describe purpose of nondestructive testing
Identify anomalies
Define defects and discontinuities
Identify factors contributing to defects and discontinuities
Describe ultrasonic testing
Describe advantages and limitations of ultrasonic testing
Describe industrial radiography
Compare use of wet and dry particles in magnetic particle inspection
Explain advantages and limitations of penetrant inspection
Describe microwave testing
Describe holographic inspection
Explain choice of most suitable nondestructive test method
Describe eddy-current testing

Unit: Technical Recording and Reporting

Competency: Demonstrate proficiency in technical recording

Competency Builders:

Describe various documentation procedures
Interpret specifications or drawings
Observe process
Ask open-ended questions
Record process (e.g., flowchart, step-by-step)
Identify parameters
Record accurate, truthful data
Maintain test logs
Compile cumulative reference notebook/record
Measure appropriate parameters
Draft preventive maintenance and calibration procedures

Competency: Demonstrate proficiency in technical reporting

Competency Builders:

Use data books and cross reference/technical manuals
Compose technical memoranda
Identify type of report or format needed
Use appropriate format
Compile relevant data
Design charts and graphs
Analyze data
Draw conclusions
Explain analytical methods used
Outline reports
Write reports
Present reports

Unit: Computer Literacy

Competency: Describe personal computer operations

Competency Builders:

Explain how data is stored in main computer memory
Explain how computer system executes program instruction
Explain computer storage capacity
Explain how data is represented
Describe data storage techniques
Identify types of memory

Competency: Explain information processing cycle

Competency Builders:

Define operating systems (e.g., DOS, OS/2, UNIX, MAC)
Describe computer languages and their use
Describe computer languages and their use
Describe computer languages and their use
Describe difference between data files and program files
Explain PC layout
Explain PC network layout
Explain mini/mainframe network layout
Differentiate hardware and software
Differentiate open from proprietary architecture

Competency: Operate computer hardware

Competency Builders:

Practice proper media handling techniques (e.g., magnetic fields, dust, liquids)
Identify hardware and its use
Use hardware (e.g., mouse, diskettes, drive, modems, touch screen, printers, digitizers, scanners, cables, protection devices)
Keyboard efficiently
Demonstrate basic care of hardware
Explain need for and application of security levels/procedures
Perform basic hardware troubleshooting
Explain hardware addressing techniques

Competency: Use software

Competency Builders:

Define software types and functions
Describe basic disk operations and care
Perform functions necessary to operate software
List advantages and disadvantages of integrated and dedicated software
Operate system software
Operate diagnostic software
Demonstrate basic proficiency in spreadsheet use
Demonstrate basic proficiency in word processing
Demonstrate basic proficiency in database use
Demonstrate basic proficiency in network use
Demonstrate basic proficiency of utility (e.g., WINDOWS, GUI)
Demonstrate basic proficiency in report writing
Demonstrate system commands
Differentiate ethical use/misuse of software
Describe bulletin boards/electronic mail
Apply security levels/procedures while handling sensitive data
Explain data compression techniques
Explain use and deletion of passwords

Competency: **Demonstrate knowledge of safety and workplace hazards**

Competency Builders:

Describe corrective procedures for unsafe conditions
Identify types and potential level of workplace hazards (e.g., physical hazards, fire, chemicals, noise, ionizing radiation, ultraviolet, temperature extremes, ergonomics, biological hazards)
Identify safety materials/equipment (e.g., absorbant socks, oil dry)
Interpret Material Safety Data Sheets (MSDS)
Explain purpose(s) of OSHA and NIOSH
Explain purpose(s) of NEC and NFPA
Identify purpose of emergency evacuation routes, master switch and lockout locations, and safety color coding systems
Identify roles of industrial hygienists, safety professionals, occupational physicians, and occupational nurses
Describe methods of evaluating potential hazards (e.g., visual analysis)
Describe methods of correcting potential hazards
Describe various types of toxicity (e.g., chronic, immediate)
Identify need for reporting accidents
Explain precautions required when using toxic or flammable materials
Define confined space and related requirements
Explain how international directives relate to safety

Competency: **Explain purpose of industrial pollution control systems**

Competency Builders:

Describe types of air, water, solid waste, and noise pollution
Explain purpose of air pollution control systems
Explain purpose of water pollution control systems
Explain purpose of solid waste pollution control systems
Explain purpose of noise pollution control systems
Explain basic philosophy of "right to know" legislation
Explain purpose(s) of EPA
Identify "costs" of industrial pollution control (i.e., dollars vs. impact to environment)
Describe ethics of environmental issues

Competency: **Demonstrate knowledge of ergonomics**

Competency Builders:

Define ergonomics
Define risk factor
Define maximum permissible limit (MPL) and action limit (AL) for lifting
Define cumulative trauma disorder (CTD)
Identify susceptibility factors for CTD
Minimize extreme joint movement
Minimize use of excessive muscle force
Minimize repetitive tasks
Minimize mechanical stresses (e.g., sharp edges, heat, cold, hard surfaces, weights, vibration)
Minimize awkward body positions
Explain use of rest pauses
Explain need for mats and footrest for standing jobs
Explain need for appropriate working heights of chairs, stools, workbenches, equipment
Explain need for adequate lighting
Explain use of anthropometric (i.e., centering one's view of everything around man) design

Unit: Basic Electronics

Competency: **Demonstrate proficiency in electronics fundamentals**

Competency Builders:

Identify electronic components and schematic symbols
Describe basic atomic structure and its relationship to electricity
Describe the relationship between electrical and magnetic properties
Describe the electrical and magnetic properties of a magnet
Describe the photoelectric effect
Describe the thermocouple effect
Describe the electrical effect of friction
Use metric units to solve electronic unit problems
Identify sources of electricity
Describe principles and operations of electrochemical supplies
Describe voltage, current, resistance, power, and energy
Apply Ohm's Law
Apply Kirchoff's Laws
Apply power formulas
Explain Thevenin's Theorem
Explain Norton's Theorem
Interpret color codes and symbols to identify electrical components and values
Measure properties of circuits using test equipment
Describe electrostatic discharge (ESD) procedures

Competency: Demonstrate proficiency in DC circuits

Competency Builders:

Compute conductance of conductors and insulators
Measure resistance and current of conductors and insulators
Measure properties of a circuit using volt-ohm meter (VOM) and digital volt-ohm meter (DVM)
Build series, parallel, and combination circuits
Build bridge circuits
Build voltage divider circuits (loaded and unloaded)
Compute voltage divider circuits (loaded and unloaded)
Demonstrate maximum power transfer theory
Describe magnetic properties of circuits and devices
Explain physical and electrical characteristics of capacitors and inductors
Describe RC and RL time constants
Compute RC and RL time constants
Demonstrate use of diodes in DC circuits
Identify need for rectification
Operate power supplies for DC circuits
Analyze frequency spectrums
Construct the operation of DC circuits that demonstrate maximum power transfer theory
Use meters and oscilloscopes
Measure current, voltage, and resistance in DC circuits
Explain simple DC generator action
Explain simple DC motor action
Explain principals of solid-state switching devices
Solve algebraic problems to include exponential (prerequisite to DC) (algebraic calculation)
Explain use of DC in relation to communications
Identify classes, voltage ratings and/or polarity of electronic components
Identify use of circuit protective devices (e.g., fuses, breakers)
Troubleshoot DC circuits

Competency: Demonstrate proficiency in AC circuits

Competency Builders:

Analyze properties of an AC signal
Describe principles and operation of characteristics of sinusoidal and non-sinusoidal wave forms
Identify AC sources
Describe principles and operation of characteristics of capacitive circuits
Operate capacitive circuits
Describe principles and operation of characteristics of inductive circuits
Operate inductive circuits
Describe principles and operation of transformers
Demonstrate operation of AC circuits utilizing transformers
Use maximum power transfer theorems
Use Thevenin's and Norton's theorem to analyze AC circuits
Measure power in AC circuits
Operate capacitor and inductor analyzers for AC circuits
Operate differentiators and integrators to determine RC and RL time constants
Describe principles and operation of characteristics of series and parallel resonant circuits
Build series and parallel resonant circuits
Identify classes, voltage, ratings and/or polarity of electronic components
Identify use of circuit protective devices (e.g., fuses, breakers)
Describe principles and operation of characteristics of frequency selective filter circuits
Calculate logarithmic to obtain gain (dB) using tables or calculator/computer
Operate frequency selective filter circuits
Operate polyphase circuits
Describe basic motor theory and operation
Describe basic generator theory and operation
Operate power supplies for AC circuits
Describe principles and operation of various power conditioning (e.g., isolation transformers, surge suppressors, uninterruptable power systems)
Describe principles and operation of various safety grounding systems (e.g., lightning arresters, ground electrostatic discharge, fault interrupters, etc.)
Describe characteristics of inductors in series and parallel circuits
Describe characteristics of capacitance in series and parallel circuits
Compare resistive-capacitive (RC) and resistive-inductive (RL) time constants (TC)
Measure voltage, current, time, frequency (f), and phase relationships of AC sine wave signal
Describe frequency (F) and phase relationships

Competency: **Demonstrate proficiency in AC circuits (CONTINUED)**

Competency Builders:

Describe resonance of inductive-capacitive (LC) circuits
Calculate impedance match and maximum transfer of power
Measure current, voltage, and resistance in AC circuits
Identify 50/60 Hertz
Explain simple AC generator action
Explain simple AC motor action
Calculate power factor in AC circuits
Explain harmonics and its effects on power quality
Solve basic trigonometric problems as applicable to electronics
Calculate peak (PK), root mean square (RMS), and average values
Troubleshoot AC circuits

Unit: Fundamentals of Electronics Technology

Competency: **Demonstrate proficiency in discrete solid-state devices**

Competency Builders:

Describe properties of semiconductor materials
Describe operating characteristics and applications of PN junctions
Demonstrate operation of diode circuits
Troubleshoot diode circuits
Repair diode circuits
Describe operating characteristics and applications of bipolar transistors
Describe operating characteristics and applications of field effect transistors
    (e.g., FET + s/MOSFET + s)
Describe operating characteristics and application of special diodes/transistors
Describe operating characteristics and applications of opto-electronic devices
    (e.g., gate isolators, interrupt sensors, infrared sensors)
Describe operating characteristics and applications of single-stage amplifiers
Demonstrate the operation of the single-stage amplifiers
Troubleshoot single-stage amplifiers
Repair single-stage amplifiers
Demonstrate the operation of thyristor circuitry (SCR, TRIAC, DIAC, etc.)
Troubleshoot thyristor circuitry (SCR, TRIAC, DIAC, etc.)
Operate analog and digital equipment for solid-state devices
Operate power supplies for solid-state devices
Operate oscilloscopes for solid-state devices
Operate function generators for solid-state devices
Operate curve tracers
Operate transistor testers

Competency: Demonstrate proficiency in analog circuits

Competency Builders:

Operate measuring instruments for analog circuits
Describe operating characteristics and applications of linear integrated circuits
Describe operating characteristics and applications of power supplies and filters
Describe operating characteristics and applications of operational amplifier circuits
Demonstrate the operation of operational amplifier circuits
Describe the operating characteristics and applications of regulated and switching power supply circuits
Demonstrate the operation of regulated power supply circuits
Describe operating characteristics and applications of active filters
Demonstrate the operation of active filter circuits
Describe operating characteristics and applications of sinusoidal and non-sinusoidal oscillator circuits
Demonstrate the operation of oscillator circuits
Describe the operating characteristics and applications of motor phase-shift control circuits (single-phase and multi-phase)
Describe the operating characteristics and applications of cathode ray tubes

Competency: Demonstrate proficiency in digital circuits

Competency Builders:

Operate logic problems for digital circuits
Operate power supplies for digital circuits
Operate pulsers for digital circuits
Operate oscilloscopes for digital circuits
Describe characteristics of integrated circuit (IC) logic families
Describe the principles and operation of types of logic gates and their truth tables
Demonstrate the use of logic gates
Describe the principles and operation of combinational logic circuits
Demonstrate the operation of combinational logic circuits
Describe the principles and operation of numbering systems, codes, and arithmetic operations
Minimize logic circuits using Boolean operations
Describe the principles and operation of types of flip-flops
Demonstrate the operation of flip-flops
Describe the principles and operation of types of registers and counters
Demonstrate the operation of registers and counters
Describe the principles and operation of clock and timing circuits
Demonstrate the operation of clock and timing circuits
Describe the principles and operation of types of arithmetic-logic circuits
Demonstrate the operation of arithmetic-logic circuits
Describe the principles and operation of types of encoders and decoders
Demonstrate the operation of encoders and decoders
Describe the principles and operation of types of multiplexer and demultiplexer circuits
Demonstrate the operation of multiplexer and demultiplexer circuits
Describe the principles and operation of digital-to-analog and analog-to-digital circuits
Demonstrate the operation of digital-to-analog and analog-to-digital circuits
Describe the principles and operation of types of digital display circuits
Demonstrate the operation of digital display circuits
Describe the types of digital display devices
Demonstrate the operation of digital display devices
Describe the operating characteristics and applications of fiber optics
Demonstrate the operation of fiber optics

Competency: Demonstrate basic proficiency in microprocessors

Competency Builders:

Describe the essential components of a microprocessor and their functions
Identify the levels of computer languages
Operate oscilloscopes and logic/data analyzers
Describe the principles and operation of BUS concepts
Describe the principles and operation of types of memory circuits
Demonstrate the operation of memory circuits
Troubleshoot memory circuits
Repair memory circuits
Describe microprocessor instruction sets
Describe the principles and operation of microprocessor machine code
Demonstrate the use of microprocessor machine code
Debug microprocessor machine code
Interface various types of peripherals
Describe the use of microprocessor simulator(s)

Competency: Describe manufacturing of electronic devices and micromechanisms

Competency Builders:

List properties of electronic packaging materials
Describe manufacturing of electronic products chips; integrated circuits; printed integrated circuits
Describe joining and assembly of electronic components
Describe coating and etching processes
List principles of packaging electronic components
Describe manufacture of miniature devices
Describe testing of joints
Describe reliability of electronic product testing
Describe the advantages and disadvantages of various advanced packaging techniques (e.g., SMD, MCM)
Describe methods of fabrication

Unit: Troubleshooting and Repair

Competency: Demonstrate troubleshooting skills

Competency Builders:

Explain role of preventive maintenance
Differentiate normal and abnormal operations
Explain troubleshooting procedures
Explain logical actions taken to troubleshoot
Use proper troubleshooting aids
Demonstrate knowledge of safety rules for troubleshooting and repair procedures
Maintain troubleshooting and repair records
Interpret prints (e.g., PID, loopsheets)
Use manufacturer's manuals, schematics, and troubleshooting charts
Isolate faults, shorts, and open circuits

Competency: Apply troubleshooting techniques to DC circuits

Competency Builders:

Identify noise problems
Isolate faults in series, parallel and series parallel
Isolate faults in bridge circuits
Isolate faults in DC power supplies
Perform polarity check
Isolate faults to DC drive system
Isolate faults in voltage divider circuits
Repair faults

Competency: Apply troubleshooting techniques to AC circuits

Competency Builders:

Isolate faults in capacitive circuits
Isolate faults in inductive circuits
Isolate faults in AC circuits utilizing transformers (e.g., step up and step down)
Isolate faults in differentiator and integrator circuits
Isolate faults in RC, RL, and RLC circuits
Isolate faults in frequency selective filter circuits
Isolate faults to AC frequency drive systems
Repair faults

Competency: Apply troubleshooting techniques in discrete solid-state devices

Competency Builders:

Isolate faults in diode circuits
Isolate faults in thyristor circuitry (e.g., SCR, TRIAC, DIAC)
Isolate faults in transistor circuits
Isolate faults in operational amplifier circuits
Isolate faults in single-stage amplifiers
Isolate faults in open circuits
Repair faults

Competency: Apply troubleshooting techniques to analog circuits

Competency Builders:

Isolate faults in single and multistage amplifiers
Isolate faults in audio power amplifiers
Isolate faults in regulated and switching power supply circuits
Isolate faults in active filter circuits
Isolate faults in oscillator circuits
Isolate faults in operational amplifier circuits
Isolate faults in power supplies (loaded and unloaded) and filters
Repair faults

Competency: **Apply troubleshooting techniques to digital circuits**

Competency Builders:

Identify noise problems
Isolate faults in multiplexer and demultiplexer circuits
Isolate faults in digital display circuits
Isolate faults in logic gates
Isolate faults in flip-flops
Isolate faults in registers and counters
Isolate faults in clock and timing circuits
Isolate faults in arithmetic-log circuits
Isolate faults in encoders and decoders
Isolate faults in digital-display devices
Repair faults

Competency: **Apply troubleshooting techniques to a microcomputer system**

Competency Builders:

Isolate faults to systems boards
Isolate faults to memory circuits
Isolate faults to data storage devices
Isolate faults in power supplies
Troubleshoot I/O ports
Isolate faults in I/O interface circuitry
Use diagnostic software
Repair faults

Competency: **Apply troubleshooting techniques to manufacturing systems**

Competency Builders:

Identify individual process blocks of assembly line or process
Identify process block interfaces
Demonstrate steps required for efficient systems troubleshooting
Isolate system faults to process block
Isolate block faults using schematics
Isolate block faults using programmable controller indicators
Isolate block faults using volt meter
Repair block faults by replacing fault component or wiring

Unit: Microcomputer Electronics Technology

Competency: **Demonstrate basic proficiency in microprocessor systems**

Competency Builders:

Describe essential components of microprocessor and their functions
Describe principles and operation of BUS concepts (e.g., VESA, EISA)
Describe principles and operation of types of memory circuits
Identify operating systems (e.g., DOS, OS/2, UNIX)
Describe microprocessor instructions sets
Describe principles and operation of microprocessor machine code
Demonstrate use of microprocessor machine code
Decode microprocessor machine code
Identify types of input and output devices and peripherals
Describe principles and operation of storage devices
Operate oscilloscopes and logic/data analyzers
Interface input and output ports to peripherals
Demonstrate ability to interface peripherals
Identify central processing unit building blocks and their uses
Identify the levels of computer languages

Competency: **Demonstrate basic proficiency in computer systems architecture**

Competency Builders:

Describe the principles and operation of computer system architecture
Operate computer system architecture
Repair computer system architecture
Describe the principles and operation of addresses and interrupts
Describe the principles and operation of volatile and non-volatile memory
Demonstrate the use of volatile and non-volatile memory
Repair or replace volatile and non-volatile memory
Describe the principles and operation of advanced memory techniques
Define individual system blocks
Draw systems configuration in block detail
Interpret computer acronyms
Describe priorities and interrupts at systems level
Identify direct memory access data handling system(s)
Define functions of advanced memory techniques (e.g., virtual, pipeline, cache)
Troubleshoot a microcomputer system

Competency: **Demonstrate proficiency in software fundamentals**

Competency Builders:

Load operating system software
Run operating system software
Load diagnostic software
Run diagnostic software
Construct flow charts
Analyze flow charts
Explain computer languages and their uses
Write a simple computer program
Write program documentation
Describe firmware applications
Identify the need for backup
Describe security measures
Describe virus protection

Competency: Describe elements of communication interfacing

Competency Builders:

Define common EIA, IEEE, and CCITT communication standards (e.g., EIA 232 and 485; IEEE 488)
Identify sync devices
Identify async devices
Identify types of network (e.g., token ring, ethernet)
Identify networking levels or layers
Identify protocols
Identify packet switching
Identify multiuser systems
Operate network analyze devices
Identify network analyzer devices (e.g., breakout bos, sniffers)

Competency: Describe peripheral equipment interfaces

Competency Builders:

Identify types of card and paper-tape equipment and interface controllers
Define printer types and interface controllers
Explain the operation of typical magnetic tape equipment and interface controllers
Identify disk equipment and interface controllers
Define environmental requirements for peripherals and media

Unit: Instrumentation Control Technology

Competency: Describe instrument loops

Competency Builders:

Use Instrumentation Society of America (ISA) symbology
Describe types of transmitters (e.g., flow, level, pressure, temperature)
Describe elements of a control loop (e.g., transmitter, indicator, controller, transducer, control
valve)
Describe signals
Describe modes of control operation (e.g., manual, automatic, cascade, program)
Describe details of flow loop [e.g., orifice plate, segmental wedge, differential pressure transmitters (electronic and pneumatic), magnetic, turbine type transmitters, local indicators, controller, transducer, control valve]
Describe types of transmitters used in level control loops
Describe details of pressure transmitters
Describe details of temperature elements (thermocouples and RTD's) and transmitters
Describe details of infrared and photosensors
Describe details of proximity/vibration sensors
Describe details of speed/acceleration sensors
Describe details of resolver encoder
Describe details of linear voltage detection transformers (LVDT)

Competency: Calibrate loop elements

Competency Builders:

Identify manufacturer's requirements
Identify loop requirements
Verify function of test equipment
Set up test procedure
Perform calibration
Record results

Competency: Build control loops

Competency Builders:

Build flow loop
Build level control loop
Build pressure loop
Build temperature loop

Competency: Perform calculations

Competency Builders:

Calculate orifice plate sizing
Calculate flow transmitter differential pressure
Calculate control valve sizing

Competency: Describe distributed control systems

Competency Builders:

Describe various types of I/O
Describe various types of alarms
Describe system architecture

Competency: Describe types of controller action

Competency Builders:

Describe proportional control action
Describe proportional and integral control action
Describe proportional, integral, and derivative control action

Competency: Perform loop tuning

Competency Builders:

Troubleshoot loops
Demonstrate effect of using only a proportional parameter
Demonstrate effect of using only proportional and integral parameters
Demonstrate effect of various values for proportional, integral, and derivative tuning parameters
Demonstrate loop training using "open loop" step testing
Demonstrate loop tuning using Ziegler Nichols method

Unit: Communications Electronics Technology

Competency: Describe transmission line applications

Competency Builders:

Explain power conversion
Describe principles and operation of two wire and four wire transmission lines
Describe principles and operation of coaxial cable
Describe principles and operation of microwave guide
Describe principles and operation of fiber optics

Competency: Demonstrate proficiency in transmitters and receivers

Competency Builders:

Explain the purpose of Federal Communication Commission (FCC) rules and regulations
Describe principles and operation of RF amplifiers
Describe principles and operation of modulation/demodulation (e.g., AM, FM, SSB, Fiber optic, DSSC)
Construct modulation/demodulation
Operate modulation/demodulation
Describe principles and operation of microwave and satellite communication systems
Describe principles and operation of repeater systems (e.g., trunk and fiber/scramble/data)

Competency: Describe various types of multiplexing systems

Competency Builders:

Describe principles and operation of analog multiplexing systems (e.g., CATV)
Describe principles and operation of digital multiplexing systems (e.g., T-1, fiber)
Describe principles and operation of CRT modulation

Competency: **Troubleshoot transmitters and receivers**

Competency Builders:

Isolate system faults in RF amplifiers
Isolate system faults in CRT modulation/demodulation circuits
Isolate system faults in RF transmitters and receivers
Isolate system faults in television modulation circuits

Competency: **Demonstrate basic proficiency in data communications**

Competency Builders:

Describe principles and operation of data communications, signaling systems, codes, formats and protocols
Describe principles and operation of parallel and serial ports
Describe principles and operation of synchronous and asynchronous signals
Describe principles and operation of data modems
Operate data modems
Describe principles and operation of fax machines
Describe principles and operation of types of carrier systems
Describe principles and operation of various types of networks (e.g., ethernet, token ring)
Demonstrate operation of various types of networks
Describe proper techniques for cable termination (e.g., UTP, COAX, FIBER)
Demonstrate proper techniques for cable termination

Competency: **Troubleshoot data communications**

Competency Builders:

Isolate system faults in data modems
Isolate system faults in various types of networks
Isolate system faults in various types of cable
Isolate system faults in various types of carrier systems

Competency: **Demonstrate basic proficiency in fiber optic communications systems**

Competency Builders:

Describe proper techniques for fiber splicing
Demonstrate proper techniques for fiber splicing
Demonstrate techniques for fiber termination
Describe basic characteristics of optics such as reflection, total reflection, and refraction
Describe characteristics and components of fiber optic cables
Describe band width and attenuation limitations for fiber optic systems
Describe technique of wavelength multiplexing in fiber optic cables
Describe characteristics of various types of light sources and light detectors used in fiber optic systems
Describe components of fiber optic transmission systems
Describe transformation of data signals into light pulses
Operate a simple fiber optic data transmission system
Describe proper techniques of fiber termination

Competency: **Demonstrate proficiency in RF systems safety**

Competency Builders:

Demonstrate safety procedures for working with RF systems antennae and support structures (e.g., towers)
Demonstrate safety procedures for working with RF systems high voltage/power supply
Demonstrate safety procedures for working with RF generators
Demonstrate safety procedures for working with RF systems in confined space

Competency: Demonstrate basic proficiency in antenna systems

Competency Builders:

Describe the principles and operation of single element antennae (e.g., 1/4 wave dipole, longwire, vertical)
Describe the principles and operation of multi-element antennae (e.g., point-to-point, broadcast)
Describe the principles and operation of impedance matching of antennae systems
Describe antennae systems measurement
Operate antennae

Unit: Industrial Electricity

Competency: Explain basic industrial electricity theory

Competency Builders:

Describe atomic structure and its relationship to electricity
Describe the relationship between electrical and magnetic properties
Describe the electrical and magnetic properties of a magnet
Describe the photoelectric effect
Describe the thermocouple effect
Describe the electrical effect of friction
Identify sources of electricity
Identify potential sources of electricity
Describe differences between AC/DC
Describe effects varying degrees of electricity have on the human body

Competency: Use the National Electrical Code (NEC)

Competency Builders:

Use NEC to identify correct materials
Use NEC to identify correct methods
Use NEC to identify correct applications
Use NEC to identify correct safety procedures

Competency: Explain operation of electrical distribution systems

Competency Builders:

Follow NFPA, local, state, and national codes
Describe functions of permits and licensing requirements
Explain generation of electricity
Explain transmission of electricity
Explain end user distribution

Competency: Maintain basic electrical systems

Competency Builders:

Replace electrical cords
Replace batteries
Replace fuse(s)
Replace switches and other sensors
Replace plugs and sockets
Replace control panel components (e.g., relays, motor starters)
Replace AC motors (e.g., 3 phase, single phase)
Replace DC motors

Competency: Interpret electrical/electronic drawings

Competency Builders:

Interpret basic electric/electronic standards and symbols (e.g., NEC, IEC)
Interpret schematic drawings
Interpret cable drawings
Interpret component drawings
Interpret logic diagrams
Interpret control panel drawings
Interpret connection drawings
Interpret interconnection drawings
Interpret printed circuit board drawings
Interpret harness drawings
Interpret package drawings
Interpret mechanical/electronic production blueprints and assembly drawings

Competency: **Demonstrate proficiency in direct current (DC) circuits**

Competency Builders:

Describe voltage, current, resistance, power, and energy
Solve algebraic problems to include exponential (prerequisite to DC)
Measure properties of a circuit using volt-ohm meter (VOM) and digital volt-ohm meter (DVM) meters and oscilloscopes
Apply Ohm's Law
Construct parallel circuits
Construct series circuits
Construct series parallel and bridge circuits
Define voltage divider circuits (loaded and unloaded)
Construct DC circuits that demonstrate the maximum power transfer theory
Solve problems in electrical units utilizing metric units
Describe the principles and operation of electrochemical supplies
Apply Kirchoff's law
Interpret color codes and symbols to identify electrical components and values
Measure properties of a circuit using analog and digital meters and oscilloscopes
Measure conductance and resistance of conductors and insulators
Describe magnetic properties of circuits and devices
Describe the physical and electrical characteristics of capacitors and inductors
Describe RC and RL time constants
Set up power supplies for DC circuits
Operate power supplies for DC circuits
Analyze frequency spectrums
Apply Thevenin's and Norton's theorems

Competency: **Demonstrate proficiency in alternating current (AC) circuits**

Competency Builders:

Solve basic trigonometric problems as applicable to electricity (prerequisite to AC)
Analyze AC signals utilizing VOM, DVM, oscilloscope, frequency counter and function generator
Analyze power in AC circuits
Measure power in AC circuits
Operate capacitor and inductor analyzers for AC circuits
Analyze properties of an AC signal
Describe the principles and operation of the characteristics of sinusoidal and non-sinusoidal wave forms
Identify AC sources
Describe the principles and operation of the characteristics of capacitive circuits
Demonstrate the operation of capacitive circuits
Describe the principles and operation of the characteristics of inductive circuits
Demonstrate the operation of inductive circuits
Describe the principles and operation of the principles of transformers
Demonstrate the operation of AC circuits utilizing transformers
Operate differentiators and integrators to determine RC and RL time constants
Describe the principles and operation of the characteristics of RLC circuits (series, parallel, and complex)
Demonstrate the operation of RLC circuits (series, parallel, and complex)
Describe the principles and operation of the characteristics of series and parallel resonant circuits
Operate series and parallel resonant circuits
Describe the principles and operation of the characteristics of frequency selective filter circuits
Demonstrate the operation of frequency selective filter circuits
Operate polyphase circuits
Describe basic motor theory and operation
Describe basic generator theory and operation
Operate power supplies for AC circuits
Describe the principles and operation of various power conditioning (e.g., isolation transformers, surge suppressors, uninterruptable power systems)
Describe the principles and operation of various safety grounding systems (e.g., lightning arresters, ground fault interrupters, etc.)
Apply maximum power transfer theorems
Apply Thevenin's and Norton's theorems to analyze AC networks

Unit: Electrical Test and Measurement Equipment

Competency: **Demonstrate proficient use of electrical test equipment**

Competency Builders:

Describe function and operation of logic probe and logic analyzer
Describe function and operation of power monitor
Describe function and operation of signal generator
Describe function and operation of spectrum analyzer
Describe function and operation of AC/DC hi-pot
Describe function and operation of time-domain reflectometer (TDR)
Describe function and operation of megger
Describe function and operation of curve tracer/analogger
Apply test equipment to DC circuits
Apply test equipment to AC circuits
Apply test equipment to solid-state devices
Apply test equipment to digital circuits
Apply test equipment to analog circuits
Apply test equipment to microprocessors

Competency: **Demonstrate proficient use of electrical measurement equipment**

Competency Builders:

Describe function and operation of analog volt-ohm-meter (AVOM)
Describe function and operation of digital volt-ohm-meter (DVOM)
Describe function and operation of amp probe
Describe function and operation of oscilloscopes
Describe function and operation of operation of infrared heat sensor
Apply measurement equipment to DC circuits
Apply measurement equipment to AC circuits
Apply measurement equipment to solid-state devices
Apply measurement equipment to digital circuits
Apply measurement equipment to analog circuits
Apply measurement equipment to microprocessors

Unit: Drafting Technology

Competency: Apply basic drafting skills

Competency Builders:

Use drafting equipment, measuring scales, drawing media, drafting instruments and consumable materials, blueprint machine
Identify line styles, weights (alphabet of lines)
Select proper drawing scale, introduction to different types
Prepare title blocks and other drafting formats
Apply freehand and other lettering techniques
Prepare multi-view drawings
Prepare multi-view sketches
Prepare orthographic views
Prepare change control block
Describe change control block/revision block
Measure angles
Draw horizontal, vertical, angular, parallel, and perpendicular lines
Transfer an angle
Construct tangent lines (to arcs) and tangent arcs (to arcs)
Bisect angles and arcs
Bisect lines
Divide lines
Construct three-point circle
Construct regular hexagon, pentagon, and octagon
Reproduce a drawing
Prepare single-view drawings
Prepare dimension drawings
Interpret notes and dimensions to determine part
Draw arcs, circles, and conics
Transfer measurements

Competency: Apply intermediate drafting skills

Competency Builders:

Describe types of blueprints and their applications
Apply isometric, oblique and perspective sketching techniques
Prepare isometric, oblique and perspective sketches
Prepare sectional views
Prepare auxiliary views
Identify ANSI symbols
Prepare views of drilled and tapped holes, counterbores, countersinks
Apply systems drafting techniques
Identify a bill of materials
Dimension drawings using ANSIy14.5 standards
Describe purpose of auxiliary and sectional views

Competency: Apply advanced drafting skills

Competency Builders:

Interpret reports and specifications
Prepare pictorial drawings
Prepare schematics
Draw conics
Interpret basic pneumatic/hydraulic standard and symbols
Interpret various drawings (e.g., welding, casting, stamping, forging, civil, maps, pattern shop)

Competency: Interpret basic prints

Competency Builders:

Visualize object from drawing
Interpret orthographic projections
Interpret isometric views
Interpret sectional views
Interpret detail and assembly drawings
Interpret dimensions
Interpret tolerances

Competency: Interpret intermediate prints

Competency Builders:

Interpret screw thread specifications
Identify structural steel shapes
Interpret special symbols
Interpret electrical, pneumatic/hydraulic drawings
Interpret schematics

Competency: Interpret advanced prints

Competency Builders:

Interpret GD&T characteristic symbols
Interpret GD&T supplementary symbols

Competency: **Demonstrate knowledge of basic geometric dimensioning and tolerancing**

Competency Builders:

Identify geometric characteristics and symbols (i.e., flatness, straightness, roundness, cylindricity, profile of line, profile of surface, perpendicularly, angularity, parallelism, circular, runout, total indicated runout, position, concentricity, and symmetry)
Define maximum material condition
Define least material condition
Define regardless of feature size condition
Describe feature control blocks
Describe datum surfaces and targets
Define flatness (pitch)
Define straightness (yaw)
Define roundness
Define cylindrically
Define profile of line
Define profile of surface
Define perpendicularity
Define angularity
Define parallelism
Define circular runout
Define total runout
Define true position concept to determine tolerance for location of holes in mating parts

Competency: **Convert dimensions and tolerances**

Competency Builders:

Convert dimensions and tolerances from English units to metric units
Convert dimensions and tolerances from metric units to English units

Competency: Apply revision control process

Competency Builders:

Apply drawing balloons
Apply documentation (including project filing, back-up material, tracking process)
Apply change control block
Apply revision levels

Competency: Demonstrate dimensioning techniques

Competency Builders:

Construct arrowheads using various styles/disciplines
Apply symbols for surface and texture control
Add labels/notes to drawing
Interpret decimal tolerance dimensions
Dimension arcs
Dimension angles
Dimension curves
Dimension rounded-end shapes
Dimension spherical objects
Dimension cylindrical objects
Dimension cones, pyramids, and prisms
Dimension features on circular center line
Dimension theoretical point of intersection
Dimension object using rectangular coordinate system
Dimension object using polar coordinate system
Dimension object using tabular coordinate system
Dimension object using ordinate dimensioning system

Competency: Apply geometric dimensioning and tolerancing

Competency Builders:

Interpret decimal tolerance dimensions
Calculate clearance fit tolerances of mating parts
Dimension clearance fit tolerances of mating parts
Calculate interference fit tolerances of mating parts
Dimension interference fit tolerances of mating parts
Calculate tolerances to mating parts using standard fit tables
Assign tolerances to mating parts using standard fit tables
Apply positional and form tolerancing symbols
Apply symbols for true position
Apply symbols for maximum material control and regardless of feature size
Calculate effects of dimensional stack-up
Calculate transitional fit tolerances
Dimension transitional fit tolerances

Competency: Perform basic physical layouts

Competency Builders:

Use inside diameter (ID), outside diameter (OD), and hermaphrodite calipers
Layout with combination square
Layout with scriber, divider and trammel
Use surface plate
Use surface gage
Use layout fluid
Use V-blocks
Use clamps
Use angle plate
Use parallels
Use punches
Use transfer method tools
Use layout hammer
Use machinist's square
Use universal bevel protractor
Use machinist's scale

Competency: **Prepare mechanical drawings**

Competency Builders:

Interpret basic mechanical standards and symbols
Prepare assembly drawings
Prepare welding drawings
Prepare bearing drawings
Prepare casting drawings
Prepare forging drawings
Prepare tool drawings
Prepare molding diagrams
Prepare drawings with special processed holes
Prepare stamping drawings
Prepare numerical control drawings/instructions
Prepare installation drawings
Prepare purchase part drawings
Prepare approval drawings

Competency: **Prepare advanced mechanical drawings**

Competency Builders:

Resolve problems by descriptive geometry and revolutions
Use precision dimensioning to include geometric characters
Use precision measuring instruments (e.g., calipers)
Prepare fastener drawings
Prepare cam drawings
Prepare gear drawings
Prepare spring drawings
Prepare pulley and chain drive drawings

Unit: CADD Fundamentals

Competency: Demonstrate basic use of computer operating system

Competency Builders:

Create ASCII text files with a text editor
Explain rules for naming files and directories
Manage files
Create directories
Remove directories
Change directories
Copy files
Rename files
Erase files
Format diskettes
Label diskettes
Explain the syntax of operating system commands
Use wildcards in operating system commands

Competency: Operate a CADD system

Competency Builders:

Execute CADD system
Use keyboard input
Use screen and tablet menus
Use other input devices (e.g., scanner, digitizer)
Create scaled plots
Operate a pen plotter
Operate a printer-plotter (i.e., laser plotter)
Access on-line help for commands
Use file conversion
Use data transfer

Competency: Select entities for action

Competency Builders:

Add or remove entities separately
Add or remove entities using a window
Add or remove entities with a crossing-box
Select entities using a fence
Select entities by other methods (e.g., last, previous, type, all, etc.)

Competency: Create 2-D orthographic drawings

Competency Builders:

Create primitive drawing entities
Draw utilizing absolute Cartesian coordinates
Draw utilizing relative Cartesian coordinates
Draw utilizing polar coordinates
Draw using construction aides (e.g., snaps, grid, snap, etc.)
Change drawing attributes
Edit drawing entity properties (e.g., color, layer, thickness, linetype)
Construct drawing entities (e.g., offset, timer, extend, break, mirror, etc.)
Edit drawing entities (e.g., offset, trim, extend, break, mirror, etc.)
Set system variables (e.g., units, scale)
Use system variables
Create layers
Name layers
Manipulate layers
Save files
Create back-ups
Create hatches, patterns, symbols
Recall drawing templates/blocks

Competency: Annotate orthographic drawings

Competency Builders:

Create text styles
Edit text styles
Select text styles
Apply notes

Competency: Dimension orthographic drawings

Competency Builders:

Create dimensions
Edit text
Control dimension variables/models

Competency: Control display

Competency Builders:

Apply view control while drawing (e.g., zoom and pan)
Control view resolution (e.g., viewers)
Save views
Display views

Competency: Extract entity and drawing information

Competency Builders:

Measure distances
Measure areas
Identify locations
List entity characteristics (e.g., length, size, location, properties, etc.)

Unit: Intermediate CADD

Competency: Manage symbols and attributes

Competency Builders:

Create blocks and W-blocks/templates
Create nested blocks/templates
Insert blocks and drawings/templates
Redefine blocks/templates
Edit blocks/templates
Apply attributes

Competency: Create 2-D isometric drawings

Competency Builders:

Manipulate snap and grid settings
Toggle planes (e.g., left, right, top)
Create text styles for each plane
Create dimension styles
Use dimension styles
Create isometric ellipses

Competency: Use external routines

Competency Builders:

Load AutoLISP programs
Execute AutoLISP programs
Load ADS programs
Execute ADS programs

Competency: Create custom menus

Competency Builders:

Demonstrate search routines when using a text editor
Write screen menus and macros
Write tablet menus and macros
Write cascading pop-down menus and macros
Write icon menus and macros
Write button menus and macros
Write other customizable CADD files (e.g., ACADD.PCP)
Edit other customizable CADD files (e.g., ACADD.PCP)

Competency: Create script files

Competency Builders:

Write a slide show script
Write a script for setting initial variable settings
Write a script for creating a title-block

Competency: Create custom linetypes

Competency Builders:

Formulate a linetype composed of long dashes
Formulate a linetype composed of lines, dashes and dots

Competency: Create 3-D wireframe models

Competency Builders:

Differentiate among extrusions, wireframes, surface models, and solid models
Create user coordinate systems
Manipulate user coordinate systems
Use cylindrical coordinates
Use spherical coordinates
Use .XYZ filters
Project geometry from one plane to another

Competency: Create 3-D surface models

Competency Builders:

Define B-rep surfaces
Differentiate B-rep surfaces and non-uniform rational B-splines (NURB's)
Create tabulated surfaces
Create ruled surfaces
Create revolved surfaces
Create edge surfaces (e.g., coon's patch)
Apply surface meshes to 3-D wireframes
Modify visibility of the edges of faces
Dimension a 3-D model for both isometric and orthographic drawings
Control dimension scale with regard to plotting scale

Competency: Apply advanced control display techniques

Competency Builders:

Define camera viewpoints and angle of rotation
Control display angle (e.g., d-view, v-point)

Unit: Equipment Installation

Competency: Explain installation procedures

Competency Builders:

Explain relocation procedures for new equipment in an existing facility
Explain the use of anchors and isolators
Explain procedures for moving and installing new equipment
Explain leveling and aligning procedures
Explain test run guidelines
Explain safety precautions for equipment installation procedures
Explain grounding procedures
Explain installation of utilities (e.g., electricity, air, water, drains)

Competency: Prepare for equipment installation

Competency Builders:

Identify equipment requirements (including safety)
Identify maintenance services needed
Identify method of moving and equipment needed
Identify measuring devices
Calculate weights
Follow manufacturer's specifications and mannuals
Identify applicable electrical, mechanical, hydraulic, and/or pneumatic principles
Read drawings/schematics
Revise drawings if applicable
Interpret prints

Competency: Install Equipment

Competency Builders:

Prepare site
Use measuring devices
Calculate weight
Follow manufacturer's specifications
Use appropriate moving equipment
Align equipment to layout specifications
Apply electrical, mechanical, hydraulic, and/or pneumatic principles

Competency: Explain rigging functions

Competency Builders:

Estimate the weight of a load
Find the center of gravity
Identify the rigging and slings used in maintenance work
Explain safety inspection procedures for rigging, ropes, and slings
Perform safety inspection procedures for rigging, ropes, and slings
Identify rope fiber types
Tie rigging knots, bends, and hitches
Identify types of wire rope
Cut wire rope assemblies and termination's
Identify cranes and hoists
Identify and explain scaffolding types
Identify safety equipment (e.g., life belts, nets, etc.)

Competency: Perform rigging functions

Competency Builders:

Perform safety inspection procedures for rigging, ropes, and slings
Tie rigging knots, bends, and hitches
Cut wire rope
Seize wire rope
Install wire rope eyes, sockets, and hooks
Splice wire rope
Erect a scaffold
Rig life belts and nets

Unit: Equipment Maintenance

Competency: Perform housekeeping

Competency Builders:

Dispose of scrap metal chips, shavings, trash and waste
Clean work area
Store hand tools, cutters, fixtures, jigs and attachments
Store grinding wheels
Follow tool crib procedures
Inspect machine guards
Replace or adjust machine guards
Report problems to supervisor

Competency: Perform recordkeeping

Competency Builders:

Explain reasons for keeping maintenance records
Explain reasons for keeping cost records
Complete work order
Complete internal requisition
Complete external requisition
Complete time cards
Complete job status reports
Complete equipment failure reports
Record preventive maintenance activities
Record repair activities
Read job orders and process sheets
Locate tooling and set up information
File reports
Prepare new/replacement equipment recommendations

Competency: Inspect machine systems

Competency Builders:

Explain planned maintenance
Explain predictive maintenance measures
Explain preventive maintenance measures (e.g., lubrication)
Log machine histories
Explain machine system(s) calibration
Inspect linkages and lever mechanisms
Inspect drive couplings
Inspect clutches
Inspect roller ball bearings
Inspect safety systems
Analyze system failure
Make minor adjustments/repairs
Coordinate maintenance services

Competency: Perform machine maintenance

Competency Builders:

Use operator's and manufacturer's manuals
Operate individual machines
Diagnose malfunctions
Apply lockout/tagout procedure
Disassemble defective section
Clean equipment
Lubricate equipment
Check equipment for wear and alignment
Repair or replace defective parts
Test machine for performance
Make minor adjustments to equipment
Prepare planned maintenance schedules
Explain breakdown maintenance

Competency: Maintain hand tools

Competency Builders:

Demonstrate use and care of measuring devices (e.g., rules, tapes, calipers, micrometers, multimeter, thermometer, and coordinate measuring system)
Demonstrate use and care of equipment used to bend and assemble rigid conduit and tubing
Demonstrate use and care of common hand tools
Demonstrate use and care of wood working tools (e.g., saws, planes, drills, hammers)
Demonstrate use and care of sheet metal tools (e.g., sheet metal gauges, hand seamers, soldering irons)
Demonstrate use and care of ropes, slings, pullers, and block and tackle
Demonstrate proper metal working bench skills (including use of vices, hacksaws, files, tapes, dies, and reamers)
Demonstrate use and care of pipe clearing equipment

Competency: Maintain portable power tools

Competency Builders:

Demonstrate use and care of light-duty and heavy-duty drills
Demonstrate use and care of electric hammers
Demonstrate use and care of pneumatic drills and hammers
Demonstrate use and care of power screwdrivers and impact wrenches
Demonstrate use and care of linear motion saws
Demonstrate use and care of circular saws
Demonstrate use and care of routers and planes
Demonstrate use and care of belt, pad and disc sanders
Demonstrate use and care of grinders and shears
Demonstrate use and care of explosive actuated tools
Demonstrate use and care of electric lifts

Competency: Maintain stationary equipment

Competency Builders:

Demonstrate use and care of mechanical presses
Demonstrate use and care of hydraulic presses
Demonstrate use and care of drill presses
Demonstrate use and care of bench grinders
Demonstrate use and care of power saws (e.g., hack, cut-off, chop, band, jig, and table)
Demonstrate use and care of band saws
Demonstrate use and care of pipe threaders
Demonstrate use and care of metal brakes
Demonstrate use and care of power shears

Unit: Electromechanical Technology

Competency: **Interpret electromechanical drawings**

Competency Builders:

Identify types of drawings and their applications
Transfer measurements
Explain the use of auxiliary views, revolutions, and sectional views
Describe dimensioning practices and techniques on drawings
Interpret mechanical/electronic production and assembly drawings

Competency: **Describe the operation of electronic sensors and transducers**

Competency Builders:

Explain temperature transducers operation
Explain stress and strain transducers operation
Explain magnetic transducers operation
Explain liquid and fluid flow transducers operation
Explain fiber optic system operation

Competency: **Demonstrate proficiency in transducers (sensors) and instrumentation**

Competency Builders:

Describe characteristics associated with transducers and instrumentation
Describe the principles and operations of various types of transducers (e.g., thermal, shock/vibration, acceleration, positional, pressure, flow, optical, gas and humidity)
Demonstrate the use of various transducers (e.g., thermal, shock/vibration, acceleration, positional, pressure, flow, optical, gas and humidity)
Troubleshoot transducers
Differentiate among thermocouple types
Interpret specifications of temperature sensors (e.g., thermocouples, thermistors, resistance temperature devices)
Interpret specification of pressure sensors (e.g., strain gage, piezzo electric/piezzo resistive) to electrical circuits
Interpret specifications of flow sensors (e.g., orifice flow meter, turbine meter, mass flow meters)
Interpret specifications of speed or position sensor (e.g., tachometer, resolver encoder, linear voltage differential transformer (LVDT)
Interpret specifications of controllers, indicators, and recorders (e.g., process controllers, programmable logic controllers with interfaces, R-chart recorders, dataloggers/indicators)
Interpret specifications of final control elements (i.e., silicon controlled rectifiers (SCR), power controllers, motor drives, actuators/robots)
Describe application circuits
Calculate specification of proximity sensors
Calculate specifications of infrared and photo-sensors
Explain use of proximity sensors
Explain use of photo electric sensors
Explain use of mechanically activated switches
Troubleshoot switch failure
Describe transducer control and measurement circuits
Demonstrate the use of control and measurement circuits
Troubleshoot control and measurement circuits

Competency: **Demonstrate proficiency in power distribution systems**

Competency Builders:

Describe power distribution systems
Describe poly-phase distribution systems
Describe single-phase distribution systems
Describe DC distribution systems
Describe delta distribution systems
Describe wye distribution systems
Describe medium-voltage distribution systems (less than 600v)
Troubleshoot poly-phase distribution systems
Troubleshoot single-phase distribution systems
Troubleshoot DC distribution systems
Troubleshoot delta distribution systems
Troubleshoot wye distribution systems
Troubleshoot medium-voltage distribution systems

Competency: **Demonstrate proficiency in power distribution equipment**

Competency Builders:

Describe power transformers
Describe power capacitors
Describe power oil switches and cutouts
Describe application of NEMA or IEC controls
Describe different types of enclosures for controls
Describe current transformers
Describe potential transformers
Describe medium-voltage circuits breakers and fuses
Use medium-voltage safety equipment
Troubleshoot power transformers
Troubleshoot power capacitors
Troubleshoot power oil switches and cutouts
Troubleshoot current transformers
Troubleshoot potential transformers
Troubleshoot medium-voltage circuit breakers and fuses

Competency: Demonstrate proficiency in motors and motor contro

Competency Builders:

Test solid state components with ohmmeter
Test solid state DC motor control circuits
Test solid state AC motor control circuits
Calibrate or recalibrate equipment
Identify SCR and TRIAC AC control circuits
Explain how load is connected to 3-phase wye configured AC generator
Identify wye connected and delta connected 3-phase motors
Explain revolving fields in AC motors
Describe operation of common AC motors
Describe operation of variable frequency AC drives
Define advantages and disadvantages of common DC motors
Explain how motor load affects speed regulation
Describe operation of stepper motors
Describe speed control of various types of motor drives using sensors
Identify defective motors
Describe regenerative dynamic breaking
Describe operation of various feedback loops

Competency: Apply quality control techniques

Competency Builders:

Perform preventive maintenance
Perform predictive maintenance
Apply statistical process control (SPC)
Recalibrate equipment
Apply problem-solving tools and techniques

Competency: **Apply electromechanical maintenance management practices**

Competency Builders:

Keep maintenance records
Complete work order
Complete internal requisition
Complete external requisition
Explain planned maintenance
Explain breakdown maintenance
Explain predictive maintenance
Establish maintenance schedules
Explain reasons for keeping maintenance records
Explain reasons for keeping cost records
Analyze system failure
Make minor adjustments/repairs
Coordinate maintenance service
Make new/replacement equipment recommendations
Interpret bill of materials for allocation, stocking, and raw material information
Analyze use of bill of materials for workplace decision making

Unit: Hydraulics and Pneumatics

Competency: Describe fluid flow concepts

Competency Builders:

Explain Pascal's Law
Explain Boyle's Law
Explain Bernoulli's Principle
Describe flow velocity
Explain how heat and pressure relate to power and transmission
Describe physical and chemical properties of a fluid
Describe fluids in motion in closed conductors
Describe continuity of mass flow
Identify types of fluids
Identify properties of fluids
Identify English and metric units of measurement for pressure, density, and viscosity

Competency: Describe energy considerations

Competency Builders:

Differentiate work and power
Differentiate potential and kinetic energy
Explain energy conservation concept
Explain hydraulic horsepower
Explain work of compression in compressible fluids

Competency: Describe system losses

Competency Builders:

Differentiate turbulent and laminar flow
Explain friction factor
Explain pressure losses
Identify potential system losses (e.g., leaks, wear, component sizing, heat, dirt)

Competency: Describe hydrostatics

Competency Builders:

Explain pressure, density, and viscosity
Explain buoyancy
Explain equilibrium

Competency: Calculate energy

Competency Builders:

Apply Pascal's Law
Apply Bernoulli's Principle
Apply Boyle's Law
Calculate work and power
Calculate potential and kinetic energy
Calculate hydraulic horsepower
Calculate flow velocity and pressure
Calculate pressure losses
Calculate laminar flow
Calculate pump capacity
Calculate system requirements

Competency: Design basic hydraulic/pneumatic system

Competency Builders:

Use common symbols
Create circuit diagrams (i.e., schematics)
Diagram closed-loop hydraulic system
Diagram an air supply system

Competency: Describe component operation

Competency Builders:

Identify functions and operation of hydraulic components
Identify functions and operation of pneumatic components
Explain application(s) of different materials (e.g., plastic, copper)

Competency: Interpret hydraulic and pneumatic schematics

Competency Builders:

Identify common symbols
Sketch circuit diagrams (i.e., schematics)
Interpret circuit diagrams (i.e. schematics)
Sketch circuit analysis
Diagram an air supply system

Competency: Troubleshoot hydraulic and pneumatic circuits

Competency Builders:

Analyze hydraulic circuits
Troubleshoot hydraulic circuits
Analyze pneumatic circuits
Troubleshoot pneumatic circuits

Competency: Perform pump maintenance and repair

Competency Builders:

Identify types and operating features of pumps
Identify pump capacity and system requirements
Explain packing and seal requirements
Explain operating principles of pumps (e.g., centrifugal, propeller and turbine rotary, metering)
Perform pump maintenance
Disassemble a pump
Reassemble a pump

Competency: **Maintain piping and accessories for high and low pressure fluid power systems**

Competency Builders:

Identify components of a piping system
Explain maintenance features of both metallic and non-metallic piping systems
Explain types of values and their operation and maintenance
Explain use and maintenance of strainers, filters, and traps in piping systems
Join common fittings
Join metallic pipe
Join plastic pipe
Join copper and steel tubing
Bend copper and steel tubing
Cut copper and steel tubing
Flare tubing

Competency: **Maintain hydraulic system components**

Competency Builders:

Install a contaminant removal system
Maintain a contaminant removal system
Explain operation and use of heat exchanges
Identify reservoir requirements
Compute hose requirements
Install hydraulic lines
Select control valves and servo-type valves
Install control valves and servo-type valves

Competency: Troubleshoot hydraulic systems

Competency Builders:

Interpret hydraulic schematic
Identify causes of failure modes
Connect electrically controlled valves
Explain hydraulic system troubleshooting techniques
Repair or replace hydraulic valves
Repair or replace hydraulic cylinders
Repair or replace hydraulic pumps and motors
Install hydraulic components

Competency: Describe reciprocating and rotary air compressors

Competency Builders:

Explain relationship of force, weight, mass, and density in pneumatic system
Explain operation of reciprocating compressors
Explain operation of rotary compressors
Explain primary and secondary air treatment (e.g., air dryers, lubricating systems)
Explain operation of compressor valves, cylinders, and motors

Competency: Maintain pneumatic systems

Competency Builders:

Install pneumatic system components
Explain pneumatic system maintenance techniques
Explain pneumatic system troubleshooting procedures
Isolate faults in air compressors
Repair or replace air compressors
Isolate faults in control valves
Repair or replace control valves
Isolate faults in air motors
Repair or replace air motors
Isolate faults in air dryers
Repair or replace air dryers
Maintain proportioning and servo valves

Competency: Troubleshoot pneumatic systems

Competency Builders:

Interpret pneumatic schematic
Diagram an air supply system
Install pneumatic system components
Explain pneumatic system troubleshooting procedures
Troubleshoot air compressors
Troubleshoot pneumatic control valves
Troubleshoot air motors
Troubleshoot air dryers

Competency: **Maintain vacuum systems**

Competency Builders:

Describe characteristics associated with vacuum systems and sub atmospheric pressure
Describe the principles and operation of vacuum gauges
Demonstrate use of vacuum gauges
Repair or replace vacuum gauges
Describe the principles and operation of vacuum pumps
Demonstrate use of vacuum pumps
Repair or replace vacuum pumps
Describe the principles and operation of vacuum controls
Demonstrate use of vacuum controls
Repair or replace vacuum controls

Unit: Programmable Logic Controllers (PLCs)

Competency: Differentiate among process controls

Competency Builders:

Describe characteristics associated with automatic controls
Define proportional control
Define integral control
Define derivative control
Describe advantages of using proportional, integral or derivative control
Describe disadvantages of using proportional, integral or derivative control

Competency: Explain basic operation of PLCs

Competency Builders:

Describe basic applications of PLCs
Identify program symbols and language functions
Describe function of block transfers
Describe operation of timers, counters, and sequences
Describe operation of analog I/O modules
Describe operation of servo motion control
Describe the principles and operation of PLCs

Competency: Demonstrate use of PLCs

Competency Builders:

Draw block diagram of a PLC
Define individual blocks of a PLC
Use operator's and/or manufacturer's manual(s)
Translate relay logic to logic for a PLC
Use function of block transfers
Operate timers, counters and sequencers
Operate analog I/O modules
Operate servo motion control
Install a PLC
Connect controller to sensors
Describe test procedures for new installation of a PLC
Troubleshoot hardware faults on a PLCs
Use safety interlock
Describe use of (Graphic Programmable Panel) GPP
Write a statement and ladder logic program
Document a statement and ladder logic program
Use a PLC program
Troubleshoot a program for a PLC
Repair a program for a PLC

Competency: **Apply robot fundamentals**

Competency Builders:

Describe the operation of robotic work cells
Operate robotic work cells
Troubleshoot robotic work cells
Repair robotic work cells
Classify robots according to industry criteria
Identify robot power drive types
Describe positioning in terms of axis, actuators and coordinate system
Identify types of control systems and sensors
Apply different methods of programming (e.g., teach, off-line)
Write simple programs to exercise robot functions
Join programs to perform full function
Identify principles of robot safety
Describe operation of various sensors used in robot control
Interface sensors to robot
Interface robots
Define open loop and closed loop control
Design a simple automated system to perform manufacturing operation
Identify operation of end-effectors

TECH PREP

"GET SERIOUS . . . ABOUT SUCCESS"

Electrical Maintenance Technician

Units to Consider: **Page**

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—NOTICE—

Each Tech-Prep Competency Profile developed should respond to the labor market demands of your Tech Prep Consortium. Therefore, the following pages should be examined carefully before being selected for use in TCP Part I. **[See "The TCP Process" for more information.]** For example, in some cases the number of units far exceeds the amount of content that can be covered within a 4 + 2 TPAD Program. All the units listed in this section will not necessarily apply to your situation, nor will all the competencies within each unit be appropriate. Note that several units appear within each specific occupation and would need to only appear once if you are compiling a cluster of occupations. **[See "TCP Matrix" and "How to Use the TCP Binder" for more information.]**

Unit: Communications Literacy

NOTE: This content was extracted from the 9-12 cluster of Ohio's Model Language Arts Program. Due to statewide initiatives other than Tech Prep, this literacy unit was not altered to meet competency-based criteria. Each literacy unit forms a critical link between academic teachers and members of business, industry, and labor. [See "The TCP Process" for more information.]

Subunit: Reading—Structure

Competencies:

RS1 Exhibit knowledge of language structure
RS2 Recognize that there may be more than one interpretation of reading selections
RS3 Recognize various literary devices
RS4 Recognize and discuss literary elements
RS5 Develop and use an increasingly sophisticated vocabulary gained through context
RS6 Apply knowledge of language structure to reading
RS7 Explain why there may be more than one interpretation of reading selections
RS8 Recognize effect of literacy devices on meaning
RS9 Analyze author's use of literary elements
RS10 Recognize relationship of structure to meaning
RS11 Describe various interpretations and meaning levels in reading selections
RS12 Characterize author's use of literary devices
RS13 Characterize use of literary techniques
RS14 Critique a variety of literature with regard to plot, dialogue, theme, setting, and characterization
RS15 Apply an expanding vocabulary gained through reading
RS16 Explain various interpretations and meaning levels in reading selections
RS17 Analyze use of literary techniques (e.g., extended metaphor, simile, personification, hyperbole, pun, alliteration)
RS18 Understand use of literary devices (e.g., irony, satire, allegory, onomatopoeia)
RS19 Analyze and synthesize pieces of literature with regard to plot, dialogue, theme, setting, and characterization

Subunit: Reading—Meaning Construction

Competencies:

RM1	Demonstrate ability to recognize appropriate pre-reading strategies
RM2	Describe effectiveness of a reading selection
RM3	Read to clarify personal thinking and knowledge
RM4	Support interpretation of text by locating and citing specific information
RM5	Develop personal response to a variety of literary works
RM6	Recognize diverse literary interpretations
RM7	Engage in self-selected reading activities
RM8	Confirm and extend meaning in reading by researching new concepts and facts
RM9	Self-monitor and apply corrective strategies when communication has been interrupted or lost
RM10	Use features of literary genres to extend meaning
RM11	Assess effectiveness of a selection read
RM12	Use reading as a possible problem-solving strategy to clarify personal thinking and knowledge
RM13	Use knowledge of semantic elements (e.g., figurative language, denotation, connotation, dialect) to clarify meaning when reading
RM14	Predict, recognize, interpret, and analyze themes based on familiarity with author's work
RM15	Compare and contrast literary genres
RM16	Assess validity and quality of selection read
RM17	Clarify meaning when reading
RM18	Compare personal reaction to critical assessment of a literary selection
RM19	Assess validity of diverse literary interpretations
RM20	Use reference books to find, evaluate, and synthesize information
RM21	Identify tone of a literary work
RM22	Critique validity of diverse literary interpretations
RM23	Integrate personal reaction to and critical assessment of a literary selection

Subunit: Reading—Application
Competencies:

RA1 Select and read material for personal enjoyment and information
RA2 Read a variety of complete, unabridged works
RA3 Employ various reading strategies according to purpose
RA4 Participate in selection of books, materials, and topics for literature study groups
RA5 Develop and apply knowledge of the interrelationship of concepts
RA6 Read selections from a variety of styles and formats, recognizing that style and format influence meaning
RA7 Extend value of reading, writing, speaking, viewing, and listening by pursuing, through reading, new concepts and interests developed as a result of these activities
RA8 Read extensively from a particular author's work and explain elements
of author's style

Subunit: Reading—Multidisciplinary
Competencies:

RM1 Connect themes and ideas across disciplines through literature
RM2 Read to facilitate learning across curriculum
RM3 Read to develop awareness of human rights and freedom
RM4 Participate actively in a community of learners
RM5 Recognize and explain interaction between literature and various cultural domains (e.g., social technological, political, economic)
RM6 Explore and analyze a variety of cultural elements, attitudes, beliefs, and value structures by men and women of many racial, ethnic, and cultural groups
RM7 Value thinking and language of others
RM8 Relate literature to historical period about which or in which it was written
RM9 Read to facilitate content learning

Subunit: Writing—Structure
Competencies:

WS1 Develop and expand a repertoire of organizational strategies (e.g., narration, comparison/contrast, and description) through a practice and discussion
WS2 Clarify word choice according to audience, topic, and purpose
WS3 Locate and correct errors in usage, spelling, and mechanics using a variety of resources
WS4 Recognize information gained from primary and secondary sources
WS5 Develop writing which contains ordered, related, well-developed paragraphs with sentences of varied lengths and patterns
WS6 Use information from a variety of sources to develop an integrated piece of writing
WS7 Evaluate and revise writing to focus on such things as audience, tone, and purpose
WS8 Recognize differences between documentation and reference list styles
WS9 Develop extended pieces of writing which contain ordered, related, well-developed paragraphs with sentences of varied lengths and patterns
WS10 Select from a repertoire of organization strategies a pattern appropriate to a topic
WS11 Synthesize information from a variety of sources
WS12 Refine word choice and tone according to audience, situation, and purpose
WS13 Appropriately cite information gained from primary and secondary sources
WS14 Use style manuals or software to prepare documentation and reference lists
WS15 Develop effectively organized pieces of expository writing containing strong voice, clear thesis, and well-developed ideas
WS16 Identify organization patterns appropriate to writing topic
WS17 Respond to others' suggested revisions to a writing piece

Subunit: Writing—Meaning Construction
Competencies:

WM1	Demonstrate knowledge of the recursive nature of the writing process by applying it appropriately to various topics, situations, and audiences
WM2	Develop criteria for writing evaluation using scoring guides and peer/teacher assistance to clarify meaning
WM3	Respond to others' suggested revisions to a piece of writing
WM4	Use word processing, graphics, and publishing aids to construct meaning in writing
WM5	Engage in self-initiated writing activities
WM6	Incorporate personal criteria with generally accepted standards for writing evaluation
WM7	Evaluate, analyze, and synthesize information for writing
WM8	Evaluate own writing using personal and established scoring criteria
WM9	Assess personal/peer revisions to a writing piece
WM10	Recognize and refine personal writing styles

Subunit: Writing—Application
Competencies:

WA1	Apply appropriate writing techniques suitable for varied writing tasks
WA2	Use sentence-combining techniques to improve syntactic fluency and maturity
WA3	Write in response to prompted and self-selected topics in practical, persuasive, descriptive, narrative, and expository domains
WA4	Develop personal voice in writing
WA5	Consider audience and purpose for writing
WA6	Develop criteria for selection and potential development of topic
WA7	Write in a journal or learning log to clarify personal thinking and knowledge
WA8	Apply an expanding vocabulary gained through writing
WA9	Make judicious use of reference sources (e.g., dictionary, thesaurus, on-lien data base, encyclopedia)
WA10	Demonstrate, an appreciation for aesthetically pleasing language through word choice and style
WA11	Apply revising and editing strategies needed for writing task
WA12	Vary sentence lengths and patterns
WA13	Refine personal voice in writing
WA14	Vary styles and formats for intended purpose and audience
WA15	Apply criteria for selection and development of topic
WA16	Participate in peer review of writing in progress
WA17	Use transitions between sentences, ideas, and paragraphs in writing
WA18	Revise and edit papers extensively in preparation for presentation/publication
WA19	Develop a variety of genres
WA20	Focus writing and tone on such elements as audience, situation, and purpose
WA21	Develop topic fully and appropriately
WA22	Use writing process to clarify personal thinking and knowledge
WA23	Apply appropriate recursive writing process as suggested by writing task and writer's process
WA24	Develop an extended piece of writing
WA25	Revise writing and tone to assure focus on such elements as audience, situation, and purpose
WA26	Use writing process to write reflectively

Subunit: Writing—Multidisciplinary
Competencies:

WM1	Use writing process for learning across curriculum
WM2	Use writing process to demonstrate knowledge of need for human rights and freedom
WM3	Value and apply collaborative skills in writing process
WM4	Write in response to reading, speaking, viewing, and listening
WM5	Use multidisciplinary resources in writing projects
WM6	Use writing process to facilitate learning across curriculum
WM7	Recognize value of and engage in collaboration in writing process
WM8	Use communication processes to develop a published writing piece in collaboration with others
WM9	Record experiences and observations related to content learning
WM10	Apply collaborative skills in writing process
WM11	Write collaboratively with peers
WM12	Use cross-disciplinary resources in writing projects

Subunit: Listening/Visual Literacy—Structure
Competencies:

LS1	Listen to and view a wide variety of genres
LS2	Become aware of an author's style through listening and viewing a variety of works
LS3	Recognize correct and appropriate grammar, diction, and syntax
LS4	Expand vocabulary through listening to and viewing varied media
LS5	Recognize beauty of language
LS6	Enhance recognition of an author's style through listening and viewing a variety of works
LS7	Recognize use and misuse of language in media
LS8	Refine knowledge of style through listening and viewing multiple works by the same author
LS9	Expand and refine grammar, diction, and syntax through listening
LS10	Compare authors' styles through viewing and listening to their works
LS11	Expand knowledge of complex grammar, diction, and syntax issues

Subunit: Listening/Visual Literacy—Meaning Construction

Competencies:

LM1	Develop critical thinking skills necessary to evaluate media and assess oral presentations
LM2	Compare new oral texts to past experiences and knowledge in order to enhance comprehension
LM3	Recognize how rhythmic patterns, silence, and cadences enhance quality of speech and literature
LM4	Focus listening and viewing on themes and/or plots
LM5	Gather information from listening and viewing experiences to enhance research
LM6	Use critical thinking skills to evaluate media and oral presentations
LM7	Use prior knowledge and experiences to facilitate comprehension of new oral texts
LM8	Identify rhythmic and time patterns in speech and literature
LM9	Identify and analyze themes and/or plots when listening and viewing
LM10	Use information gathered from listening and viewing experiences to expand research
LM11	Enhance use of critical thinking skills to evaluate media and oral presentations
LM12	Consider prior knowledge and experiences when attempting to understand the meaning of new texts
LM13	Appreciate rhythmic and time patterns of speech and literature
LM14	Select viewing and listening materials to support written text
LM15	Evaluate media and oral presentations analytically and critically
LM16	Organize prior knowledge and experiences to comprehend new texts
LM17	Organize and use viewing and listening materials to support written text

Subunit: Listening/Visual Literacy—Application

Competencies:

LA1	Listen attentively during oral reading
LA2	Use media as stimuli for learning and thinking
LA3	Develop knowledge of structure through art, music, and literature
LA4	Use electronic media to enhance and highlight language learning
LA5	Listen and view for entertainment and enjoyment
LA6	Use technology and other media as means of expressing ideas

Subunit: Listening/Visual Literacy—Multidisciplinary

Competencies:

LM1	Facilitate learning across curriculum through critical listening and viewing
LM2	Engage in individual, small-group, and whole-group listening and viewing activities
LM3	Develop language arts (e.g., viewing, listening) projects collaboratively
LM4	Investigate language and cultural differences through listening and viewing activities
LM5	Participate in a community of learners through productive listening

Subunit: Oral Communication—Structure

Competencies:

OS1	Refine oral communication skills
OS2	Demonstrate knowledge of grammar, usage, and syntax when presenting
OS3	Select topics and vocabulary suitable to audience
OS4	Organize notes and ideas for speaking
OS5	Use language imaginatively
OS6	Modulate voice to meaning when interpreting literature orally
OS7	Organize notes and ideas for formal, semiformal and informal presentations of information
OS8	Refine speaking techniques for formal, semiformal, and informal settings
OS9	Develop repertoire of organizational strategies for presenting information orally
OS10	Expand vocabulary to fit topic
OS11	Select topics suitable to audience, situation, and purpose
OS12	Select appropriate strategies when organizing notes and ideas for speaking

Subunit: Oral Communications—Meaning Construction

Competencies:

OM1	Make connections between prior knowledge and new information for oral presentations
OM2	Participate in informal speaking activities
OM3	Use interviewing techniques to gather information
OM4	Communicate orally to entertain and to inform
OM5	Participate in group communication activities
OM6	Take and organize notes when preparing speech/presentation
OM7	Interpret texts orally to illustrate meaning
OM8	Respond to needs of various audiences
OM9	Gather and assess information for speaking
OM10	Communicate orally to inform and persuade
OM11	Prepare and deliver formal speech/presentation
OM12	Participate in a variety of oral interpretations
OM13	Assess needs of audience and adjust language and presentation according to their knowledge
OM14	Analyze and synthesize information for speaking
OM15	Describe effectiveness of literary selection
OM16	Describe topic or idea in order to clarify personal/audience thinking
OM17	Analyze and synthesize information gathered from a variety of sources for speaking
OM18	Describe validity and/or quality of a literary selection and justify selection
OM19	Interpret orally a variety of literature
OM20	Describe topic or idea to clarify meaning for others

Subunit: Oral Communication—Application

Competencies:

OA1	Become proficient at using interviewing techniques
OA2	Give an oral interpretation for a specific audience
OA3	Develop and apply oral communication skills for cooperative/collaborative learning
OA4	Use oral communication for a variety of purposes and audiences (e.g., negotiations, book reviews, rationales)
OA5	Develop and apply decision-making strategies
OA6	Practice interviewing techniques
OA7	Apply interviewing techniques to purposeful interviews
OA8	Focus oral interpretation on a specific audience

Subunit: Oral Communications—Multidisciplinary Competencies:

OM1	Value thinking and language of others
OM2	Develop oral projects collaboratively
OM3	Be involved in individual, small-group, and whole-group language activities
OM4	Participate actively in a community of learners
OM5	Investigate language and cultural differences through oral language activities

Unit: Mathematics Literacy

NOTE: This content was extracted from the 9-12 cluster of Ohio's Model Mathematics Program. Due to statewide initiatives other than Tech Prep, this literacy unit was not altered to meet competency-based criteria. Each literacy unit forms a critical link between academic teachers and members of business, industry, and labor. [See "The TCP Process" for more information.]

Subunit: Numbers and Number Relations

Competencies:

NR1	Compare, order, and determine equivalence of real numbers
NR2	Estimate answers, compute, and solve problems involving real numbers
NR3	Compare and contrast real number system, rational number system, and whole number system
NR4	Extend knowledge to complex number system and develop facility with its operation

Subunit: Measurement

Competencies:

M1	Estimate and use measurements
M2	Understand need for measurement and probability that any measurement is accurate to some designated specification
M3	Understand and apply measurements related to power and work
M4	Understand and apply measurement concepts of distance-rate-time problems and acceleration problems
M5	Use real experiments to investigate elasticity, heat, sound, electricity, magnetism, light, acceleration, velocity, energy, and gravity
M6	Use real-world problem situations involving mass and weight
M7	Use real-world problem situations involving simple harmonic motion
M8	Establish ratios with and without common units
M9	Construct and interpret maps, tables, charts, and graphs as they relate to real-world mathematics
M10	Understand and solve rate-change problems
M11	Understand and solve right triangle relationships as they relate to measurement, specifically to Pythagorean theorem
M12	Graph and interpret ordered pairs
M13	Compute total sales from a variety of items
M14	Comprehend and compute rates of growth or decay
M15	Comprehend, compute, and interpret real problems involving annuities

Subunit: Measurement (continued)
Competencies:

M16	Develop an ability to identify real problems and provide possible solutions
M17	Express and apply different types of measurement scales
M18	Identify area and volume

Subunit: Estimation and Mental Computation
Competencies:

E1	Use estimation to eliminate choices in multiple-choice tests
E2	Use estimation to determine reasonableness of problem situations in a wide variety of applications
E3	Estimate shape of graphs of various functions and algebraic expressions
E4	Use mental computation when computer and calculator are inappropriate

Subunit: Data Analysis and Probability
Competencies:

D1	Organize data into tables, charts, and graphs
D2	Understand and apply measures of central tendency, variability, and correlation
D3	Use curve fitting to predict from data
D4	Use experimental or theoretical probability, as appropriate, to represent and solve problems involving uncertainty
D5	Use computer simulations and random number generators to estimate probabilities
D6	Test hypotheses using appropriate statistics
D7	Read, interpret, and use tables, charts, and graphs to identify patterns, note trends, draw conclusions, and make predictions
D8	Identify probabilities of events involving unbiased objects
D9	Use sampling and recognize its role in statistical claims
D10	Design a statistical experiment to study problem, conduct experiment, and interpret and communicate outcomes
D11	Describe normal curve in general terms and use its properties
D12	Create and interpret discrete probability distributions
D13	Understand concept of random variable
D14	Apply concept of random variable to generate and interpret probability distributions, including binomial, uniform, and chi square

Subunit: Algebra
Competencies:

A1 Describe problem situations by using and relating numerical, symbolic, and graphical representations
A2 Use language and notation of functions in symbolic and graphing settings
A3 Recognize and use equivalent zeros of a function, roots and the solution of an equation in terms of graphical and symbolic representations
A4 Describe and use logic of equivalence in working with equations, inequalities, and functions
A5 Develop graphical techniques of solution for problem situations involving functions
A6 Explore and describe characterizing features of functions
A7 Make arguments and proofs in algebraic settings
A8 Factor difference of two squares
A9 Identify slope, midpoint, and distance
A10 Explore and combine rational functions
A11 Explore factoring techniques
A12 Solve quadratic equations by factoring and formula
A13 Set up and solve linear equations
A14 Solve systems of linear equations with two variables
A15 Describe geometric situations and phenomena using variables, equations, and functions
A16 Describe measures of central tendency, mean, median, mode, and variance algebraically and graphically
A17 Represent inequalities on number line and in coordinate plane
A18 Use coordinate arguments in making geometric proofs
A19 Symbolize transformations of figures and graphs
A20 Explore geometric basis for functions of trigonometry
A21 Graph linear functions
A22 Develop and use vectors to represent direction and magnitude including operations
A23 Use polar and parametric equations to describe, graph, and solve problem situations
A24 Represent sequences and series as functions both algebraically and graphically
A25 Explore recursive functions and procedures using spreadsheets, other computer utilities, and appropriate notions
A26 Describe and solve algebraic situations with matrices
A27 Describe and use inverse relationship between functions including exponential and logarithmic

Subunit: Algebra (continued)
Competencies:

A28 Analyze and describe errors and error sources that can be made when using computers and calculators to solve problems
A29 Decide whether problem situation is best solved using computer, calculator, paper and pencil, or mental arithmetic/estimation techniques
A30 Explore relationships between complex numbers and vectors
A31 Make arguments concerning limits, convergence and divergence in context involving sequences, series, and other types of functions
A32 Represent transformations in plane with matrices
A33 Contrast and compare algebra's of rational, real, and complex numbers with characteristics of a matrix algebra system
A34 Construct polynomial approximations of a function over specified intervals of convergence
A35 Examine complex numbers as zeros of functions
A36 Translate verbal statements into symbolic language
A37 Simplify algebraic expressions
A38 Use laws and exponents (including scientific notation)
A39 Expand and extend idea of vectors and linear algebra to higher dimensional situations
A40 Use the idea of independent basis elements for a vector space and associated fundamental concepts of finite dimensional linear algebra
A41 Develop and communicate arguments about limit situations
A42 Use matrices to describe and apply transformations
A43 Develop and use polar and parametric equations to represent problem situations
A44 Explore proofs by mathematical induction

Subunit: Geometry
Competencies:

G1	Create and interpret drawings of three-dimensional objects
G2	Represent problem situations with geometric models and apply properties of figures
G3	Apply Pythagorean theorem
G4	Demonstrate knowledge of angles and parallel and perpendicular lines
G5	Explore inductive and deductive reasoning through applications to various subject areas
G6	Translate between synthetic and coordinate representations
G7	Identify congruent and similar figures using transformation with computer programs
G8	Deduce properties of figures using transformations and coordinates
G9	Use deductive reasoning
G10	Explore compass and straightedge constructions in context of geometric theorems
G11	Demonstrate knowledge of and ability to use proof
G12	Use variety of proof techniques (e.g., synthetic, transformational, and coordinate)
G13	Use variety of proof formats, including T-proof (i.e., two-column) and paragraph proof
G14	Explore different proof strategies
G15	Investigate different proofs of theorems
G16	Develop knowledge of an axiomatic system
G17	Apply transformations and coordinates in problem solving
G18	Represent problem situations with geometric models and apply properties of figures
G19	Deduce properties of figures using vectors
G20	Analyze properties of Euclidean transformations and relate translations to vectors
G21	Apply vectors in problem solving
G22	Develop further knowledge of axiomatic systems by investigating and comparing various geometry's

Subunit: Patterns, Relations, and Functions
Competencies:

P1	Model real-world phenomena with polynomial and exponential functions
P2	Explore relationship between zeros and intercepts of functions
P3	Translate among tables, algebraic expressions, and graphs of functions
P4	Use graphing calculator or computer to generate graph of a function
P5	Explore relationship between a linear function and its inverse
P6	Describe and use characteristics of polynomial functions in problem-solving situations
P7	Explore conic sections and graph using graphing calculator or computer
P8	Apply trigonometric functions to problem situations involving triangles
P9	Discover relationships between algebraic description, kind, and properties of conic
P10	Explore periodic real-world phenomena using sine and cosine functions
P11	Analyze effects of parameter changes on graphs
P12	Use graphing calculator or computer to graph functions
P13	Develop an knowledge of rational and transcendental functions
P14	Understand connections between trigonometric and circular functions
P15	Use circular functions to model periodic real-world functions
P16	Solve trigonometric equations and verify trigonometric identities
P17	Understand connections between trigonometric, exponential, and logarithmic functions and polar coordinates, complex numbers, and series
P18	Model real-world phenomena with a variety of functions
P19	Graph using polar coordinates
P20	Explore graphs in three dimensions
P21	Explore functions of several variables
P22	Explore recursive functions using spreadsheets and/or programming languages

Unit: Science Literacy

NOTE: This content was extracted from the 9-12 cluster of Ohio's Draft Model Science Program. Due to statewide initiatives other than Tech Prep, this literacy unit was not altered to meet competency-based criteria. Each literacy unit forms a critical link between academic teachers and members of business, industry, and labor. [See "The TCP Process" for more information.]

Subunit: Scientific Inquiry
Competencies:

Q1 Check the appropriateness and accuracy of measures and computations using various strategies (e.g., estimations, unit analysis, determination of significant figures)
Q2 Use ratios, proportions, and probabilities in appropriate problem situations
Q3 Translate information from and represent information in various forms with equal ease (e.g., tables, charts, graphs, diagrams, geometric figures)
Q4 Use existing algebraic formulas and create new ones in appropriate problem-solving situations
Q5 Estimate and justify probabilities of outcomes of familiar situations based on experimentation and other strategies
Q6 Invent apparatus and mechanical tools needed to perform unique tasks in various situations
Q7 Identify, compare, and contrast different modes of inquiry, habits of mind, and attitudes and dispositions
Q8 Design investigations that are safe and ethical (i.e., obtain consent and inform others of potential outcomes, risks and benefits, and show evidence of concern for human health and safety, concern for non-human species)
Q9 Make and read scale drawings, maps, models, and other representations to aid planning and understanding
Q10 Seek elaboration and justification of data and ideas, and reflect on alternative interpretations of the information
Q11 Use appropriate units for counts and measures
Q12 Create and use databases (electronic and other) to collect, organize, and verify data and observations
Q13 Design and conduct investigations with multiple variables
Q14 Communicate the results of investigations clearly in a variety of situations

Subunit: Scientific Inquiry (continued)
Competencies:

Q15 Examine relationships in nature, offer alternative explanations for the observations, and collect evidence that can be used to help judge among explanations

Q16 Trace the development (e.g., history, controversy, and ramifications) of various theories, focusing on supporting evidence and modification with new evidence

Q17 Select, invent, and use tools, including analog and digital instruments, to make and record direct measurements

Q18 Observe and document events and characteristics of complex systems

Q19 Explain the influence of perspective (e.g., spatial, temporal, and social) on observation and subsequent interpretations

Q20 Create multiple representations of the same data using a variety of symbols, descriptive languages, mathematical concepts, and graphic techniques

Q21 Generate testable hypotheses for observations of complex systems and interactions

Q22 Document potentially hazardous conditions and associated risks in selected homes and public areas

Q23 Participate in public debates, relying on documented and verified data to construct and represent a position on scientific issues

Q24 Construct and test models of physical, biological, social, and geological systems

Q25 Read, verify, debate, and, where necessary, refute research published in popular or technical journals of science (e.g., *Discover*, *Omni*, *Popular Mechanics*)

Q26 Explore discrepant events and develop and test explanations of what was observed

Q27 Conduct theory-based research using surveys, observational instruments, and other methods

Q28 Modify personal opinions, interpretations, explanations, and conclusions based on new information

Q29 Analyze error and develop explanations in various domains

Q30 Formulate taxonomic schemes based upon multivariate models that help to explain similarities and differences in form, distribution, behavior, survival, and origin of objects and organisms

Q31 Demonstrate various logical connections between related concepts (e.g., entropy, conservation of energy)

Q32 Account for discrepancies between theories and observations

Q33 Analyze the changes within a system when inputs, outputs, and interactions are altered

Subunit: Scientific Inquiry (continued)
Competencies:

Q34 Create, standardize, and document procedures
Q35 Determine the sources of significant disparities between the predicted and recorded results and change research procedures to minimize disparities
Q36 Research, locate, and propose applications for abstract patterns (e.g., fractals, Fibonacci sequences, string theory, orbitals)
Q37 Recognize and utilize classification systems for particles, elements, compounds, phenomena, organisms, and others for exploring and predicting properties and behaviors
Q38 Suggest and defend alternative experimental designs and data explanations (e.g., sampling, controls, safeguards)
Q39 Recognize and communicate differences between questions that can be investigated in a scientific way and those that rely on other ways of knowing
Q40 Draw conclusions based on the relationships among data analysis, experimental design, and possible models and theories
Q41 Suggest new questions as a result of reflection on and discussions about their own scientific investigations
Q42 Investigate, assess, and comment on strengths and weakness of the descriptive and predictive powers of science
Q43 Create new information from representations of data in a variety of forms (e.g., symbols, descriptive languages, graphic formats) utilizing a variety of techniques (e.g., interpolations, extrapolations, linear regressions, central tendencies, correlation's)

Subunit: Scientific Knowledge
Competencies:

K1 Investigate various types of dynamic equilibrium (e.g., biological, geological, mechanical, chemical)

K2 Investigate the relationship between the rates of energy exchange and the relative energy level of components with systems (e.g., tropic levels of ecosystems, osmosis, rate of heating and cooling, storms)

K3 Investigate patterns in the natural world (e.g., heredity, crystalline structures, population and resource distributions, diffraction, dispersion, polarization)

K4 Investigate models and theories that help to explain the interactions of components in systems (e.g., conservation of mass, energy, and momentum; food webs; natural selection; entropy; plate tectonics; chaos; relativity; social-psychology)

K5 Investigate degrees of kinship among organisms and groups of organisms

K6 Investigate the limits of the definition of life, and investigate organisms and physical systems that exist at or near these limits (e.g. viruses, quarks, black holes)

K7 Investigate estimates and measurements of a wide range of distances and rates of change

K8 Investigate the historical development of theories of change over time (e.g., natural selection, continental drift, the big bang, geologic change)

K9 Investigate physical and chemical changes in living and non-living systems (e.g., photosynthesis, weathering processes, glaciation, thermal effects of materials, energy cells)

K10 Investigate simulations of nuclear change (e.g., radioactivity, half life, carbon dating)

K11 Investigate conservation principles associated with physical, chemical, and nuclear changes

K12 Formulate descriptions of the impacts of various forms of mechanical and electromagnetic waves on various organisms on each other over time

K13 Formulate models and hypotheses for patterns in the natural world (e.g., earth structures, transportation systems, migrations, communications, constellations)

K14 Formulate explanations for the influences of objects and organisms on each other over time

K15 Formulate and interpret explanations for change phenomena (e.g., mass extinction's, stellar evolution, punctuated equilibrium, molecular synthesis)

Subunit: Scientific Knowledge (continued)
Competencies:

K16 Formulate and interpret explanations for the magnitudes of diversity at different periods of geologic time (e.g., mutation, global cataclysms, continental drift, competition, mass extinction's)

K17 Formulate interpretations of the structure, function, and diversity in a variety of organisms and physical systems (e.g., DNA and RNA variants, nucleons, interaction particles)

K18 Formulate understandings of geologic time (e.g., millennia, periods, epochs)

K19 Formulate an understanding of the historical development of the model of the universe

K20 Formulate explanations and representations of the production, transmission, and conservation of energy in biological and physical systems (e.g., weather, volcanism, earthquakes, electricity, magnetism, cellular respiration)

K21 Formulate models and hypotheses about patterns in the natural world (e.g., social behavior, molecular structure, energy transformation, entropy, randomness, aging, chaos, hormonal cycles)

K22 Formulate interpretations of the relationship between energy exchange and the interfaces between components within systems

K23a Formulate estimations for the range of energies within and between various phenomena (e.g., thermal, electromagnetic, thermonuclear, chemical, electrical)

K23b Formulate explanations for the historical development of descriptions of motions interactions and transformations of matter and energy (e.g., classical Newtonian mechanics, special and general relativity, chaos)

K24 Formulate models that can be used to describe fundamental molecular interactions in living and non-living systems (e.g., cell membranes, semiconductors).

K25 Formulate an understanding of the degree of relationship among organisms and objects based on molecular structure (e.g., proteins, nucleic acids)

K26 Formulate hypotheses and models that may account for observable events (e.g., electricity and magnetism, gravitation, atoms, bonding, chemical reactions, quantum effects, energy flow on biological systems, predator-prey relationships)

K27 Formulate models and hypotheses about change over time (e.g., natural selection, speciation, punctuated equilibrium, phyleytic gradualism, stellar evolution, plate tectonics, radioactive decay, quantum mechanical theory)

Subunit: Scientific Knowledge (continued)
Competencies:

K28 Formulate lists of limitations and propose refinements of standard classification systems (e.g., periodic table, IUPAC, Linnean, standard model)

K29 Formulate specific cases of limitations and possible exceptions of theories and principles regarding the interactions of moving objects and organisms (e.g., fluid flow in vessels, motion near the speed of light, Heisenberg uncertainty principle, meteorological prediction, local variation and diversity, predicting earthquakes, energy transport in cellular respiration)

K30 Formulate plans and contingencies that can be used to accommodate for changes to and stresses on systems (e.g., wildlife and habitat management, corrosion prevention, noise abatement, structure design)

K31 Formulate models of molecular, atomic, ionic, and subatomic structures and the physical and biological implications of these structures (e.g., genes, nucleons, quarks)

K32 Formulate estimates for a wide range of measurements and scales (e.g., angstroms to light years)

K33 Formulate and interpret representations of time from origin to present accounting for phenomena of scale (e.g., smoothness, punctuation's, chaos)

K34 Formulate interpretations of the historical development of various theories of possible causes of diversity among physical and biological phenomena (e.g., the works of Aristotle, Mendel, Darwin, McClintock)

K35 Formulate models and hypotheses that can be used to explain the interactions of components within technological and ecological systems

Subunit: Conditions for Learning Science
Competencies:

C1 Participate actively in dialogue about and resolution of community issues

C2 Assess information from various countries in the original language or translated form to ascertain the perspectives of many cultures

C3 Analyze the scientific ideas presented in science fiction stories and films

C4 Perform and repeat investigations to verify data, determine regularity, and reduce the impact of experimental error

C5 Present the results of investigations in a variety of forums

C6 Contribute to the decisions regarding topics for investigation

C7 Use various creative means to communicate interpretations of scientific ideas, concepts, phenomena, and events

C8 Consider the scientific thinking and language of others

C9 Individually and collaboratively produce clearly written representations of investigative results

C10 Fulfill responsibilities as part of a research group

C11 Select and utilize resources by various criteria (e.g., efficiency, effectiveness, health, safety) that are appropriate to the investigations being conducted by groups

C12 Present persuasive argument based on the scientific aspects of controversial issues

C13 Collect, store, retrieve, and manipulate information with available t technologies alleges that may range from hand processes up through computer applications

C14 Investigate social issues with a scientific perspective (e.g., human rights, wellness, economics, futurism, environmental ethics)

C15 Keep journals of observations and inferences made over an extended period of time and reflecting upon the impact of these recorded ideas on their thinking and actions

C16 Examine the intellect, perspectives, and ethics of notable scientists

C17 Collect and analyze observations made over extended periods of time and compare these to scientific theories

C18 Create presentations of scientific understandings using diverse modes of expressions

C19 Conduct formal scientific debates in the classroom

C20 Wonder about the likelihood of events that may occur by chance or coincidence

C21 Plan and conduct field trips and experiences for small and large groups

C22 Analyze the historical context which leads to and has lead to scientific t theories

Subunit: Conditions for Learning Science (continued)
Competencies:

C23 Seek information on topics of personal scientific interest from a variety of sources
C24 Conduct learner-developed investigations independently and collaboratively over periods of week and months
C25 Listen attentively and critically to presentations of scientific information made by others
C26 Conduct analyses of propaganda related to scientific issues
C27 Perform investigations that require observations over varying periods of time
C28 Experience scientific concepts as interpreted by other cultures through multimedia and local and global specialists
C29 Access appropriate technology to perform complicated, time-consuming tasks
C30 Relate historical accounts of science to the cultural context in which they were written
C31 Work as a contributing member of a collaborative research group
C32 Examine the influences of social and political structures and realities that contribute to inquiry about scientific issues
C33 Use technology (e.g., desktop publishing, teleconferencing, networking) to communicate scientific ideas
C34 Explore and analyze a variety of perspectives on science (e.g., works by men and women of many racial, ethnic, and cultural groups)
C35 Lead groups of learners of various ages in designing, planning, and conducting science activities
C36 Respect the scientific thinking of others and self
C37 Recognize and contrast different epistemologies
C38 Develop possible courses of action in response to scientific issues of local and global concern
C39 Determine the validity of research conclusions in relation to the design, performance, and results
C40 Develop multimedia presentations of group and individual research projects and investigations appropriate for a variety of audiences and forums
C41 Produce interesting and scientifically correct stories and present them using various modes of expression
C42 Reflect on the ideas and content found in their own journal records
C43 Examine ambiguous results and formulate explanations
C44 Recognize and synthesize the contributions to scientific thought of individuals from many cultures

Subunit: Conditions for Learning Science (continued)
Competencies:

C45 Construct models and simulations of the component structures and functions of living and non-living entities

C46 Lead multi-age groups in the examination of and planned resolution for scientific issues

C47 Recognize and choose members of research teams based upon the merit of their ideas and skills

C48 Construct a portfolio of products, documentation, and self-evaluations of his/her own abilities, skills, and experiences

C49 Synthesize scientific information from a variety of sources

C50 Evaluate and prioritize scientific issues based upon risk-benefit analyses

C51 Refining scientific skills from a variety of experiences

Subunit: Applications for Science Learning
Competencies:

A1 Answer student-determined questions by designing databases and drawing inferences from the analyses of the information in these data bases

A2 Make personal behavior decisions by interpreting information that has a scientific basis

A3 Propose courses of action that will validate and demonstrate personal understandings of scientific principles

A4 Guide other learners in their understanding of the interactions of technologies and society at various periods in time

A5 Promote and carry out practices that contribute to a sustainable environment

A6 Study and propose improvements in public services and systems in their community

A7 Choose consumer materials utilizing personal and environmental risk and benefit information

A8 Make inferences and draw conclusions using databases, spreadsheets, and other technologies

A9 Do simple trouble-shooting on common electrical and mechanical systems, identifying and eliminating possible causes of malfunctions

A10 Construct devices that perform simple, repetitive actions

A11 Investigate the functionality of various geometric shapes in the natural world and the designed world (e.g., translations from spherical to plane representations cause distortions, triangular shapes contribute to rigidity and stability in structures, round shapes minimize boundary for a given capacity)

A12 Make decisions regarding personal and public health

A13 Evaluate the social and ecological risks and benefits resulting from the use of various consumer products

A14 Analyze the contributions of advances in technology through history to his/her everyday life

A15 Identify and reduce risks and threats to a sustainable environment

A16 Extend the limits of human capabilities using technological enhancements

A17 Use and recognize various propaganda techniques

A18 Solve unique problems using the results of systematic analyses

A19 Choose everyday consumer products that utilize recent innovation and pass appropriate performance criteria

A20 Refine personal career interests through investigations of the diversity of manufacturing, research, service, and invention processes

Subunit: Applications for Science Learning (continued)
Competencies:

A21 Predict and investigate the working of toys and tools while controlling and manipulating variables (e.g., friction, gravity, forces)
A22 Write, follow, modify, and extend instructions (e.g., equations, algorithms, formulas, flow diagrams, illustrations)
A23 Create products, make inferences, and draw conclusions using databases, spreadsheets, and other technologies
A24 Predict various scenarios and propose solutions to community issues using scientific information (e.g., actuarial tables, census data, topographic maps, incidence data, climatic data)
A25 Use scientific evidence to consider options and formulate positions about the health and safety of others and him/herself
A26 Search for, use, create, and store objects and information using various strategies and methods of organization and access
A27 Research and write environmental impact statements of his/her own design
A28 Compare school-based science perspectives with those gained through cutting-edge technological applications
A29 Design management plans for natural and human-altered environments (e.g., woodlots, patios, lots, lawns, farmlands, forests)
A30 Refine personal career interests
A31 Promote public awareness of the interaction of technology with social i issues
A32 Advocate and propose courses of action for local and global scientific issues using global networks
A33 Use appropriate technologies to prepare and present the findings of investigations incorporating tables, graphs, diagrams, and text
A34 Make informed consumer choices by evaluating and prioritizing information, evidence, and strategies
A35 Develop an informed point-of-view that allows for validation or refutation of the scientific statements and claims of advocated before pursuing courses of action (e.g., contributing support, signing petitions, casting votes)
A36 Differentiate between observations and inferences in the exploration of evidence related to personal, scientific, and community issues
A37 Develop and write environmental impact and safety and hygiene management plans
A38 Use technology to collect, analyze, and communicate information (e.g., electronic networks, desktop publishing, remote sensing, graphing calculators, satellite telemetry, and others)
A39 Design, construct, and market inventions

Unit: Technology Literacy

NOTE: Over 500 Ohio business, industry, and labor representatives examined, altered, and then verified the content for this unit during the TCP Process. The original content was extracted from the Report of the Task Force on Technology Competence—Learner Goals for All Minnesotans, published by the Minnesota State Council on Vocational Technical Education. The Technology Literacy unit forms a critical link between all teachers and stresses the importance of technological impact on teaching and learning. [See "The TCP Process" for more information.]

Competencies:

T1 Demonstrate a systems view of technology based on the interdependence of social, political, economic, and ecological systems
T2 Assess the career, family, and personal development implications of technological change
T3 Demonstrate continuous learning via technology
T4 Demonstrate global appreciation for technology's potential effects on cultures, geographic areas, and the environment
T5 Apply historical perspective on technology to the development and use of new technologies
T6 Apply diverse technologies to store, access, process, create, and communicate information needed to solve problems
T7 Apply legal principles and ethical conduct to the use of technology
T8 Demonstrate competency in mathematics, science, social sciences, communication, and computer skills through the analysis, design, and evaluation of technological systems
T9 Analyze the potential of alternative technological systems to solve problems and/or to extend human capabilities
T10 Use a variety of tools, materials, and equipment in solving problems and extending human capabilities
T11 Assess risks and benefits of technological developments from an ecological, economic, social, and political perspective
T12 Value human diversity as part of a team in suggesting, designing, and testing solutions to technological problems

Unit: Employability Skills

Competency: **Develop a career plan**

Competency Builders:

Identify current interests and aptitudes
Identify common barriers to employment
Describe strategies to overcome employment barriers
Locate resources for finding employment
Research job trends
Identify career options
Identify advantages and disadvantages of career options (in addition to other than monetary)
Identify job requirements
Investigate education/training opportunities
Evaluate personal strengths and weaknesses

Competency: Prepare for employment

Competency Builders:

Identify traditional and non-traditional employment sources
Identify present and future employment opportunities (by geographic location)
Research job opportunities, including non-traditional careers
Compare salary ranges and benefit packages
Compile occupational profile
Identify rights and responsibilities of equal employment opportunity laws
Design resume and cover letter
Target resume
Secure references
Investigate generic and specific employment tests (e.g., civil service exam; drug screening)
Use follow-up techniques to enhance employment potential
Demonstrate legible written communication skills using correct grammar, spelling, punctuation, and concise wording
Describe methods for handling illegal questions on job application forms and during interviews
Write letter of application
Research prospective employer and services performed
Explain critical importance of personal appearance, hygiene, and demeanor
Interpret job description
Demonstrate appropriate interview question and answer techniques
Demonstrate methods for handling difficult interview questions
Evaluate job offers
Write letter of acceptance
Write letter of declination
Demonstrate good listening skills
Ask for the job tactfully
Participate in extracurricular activities (e.g., student government, community projects,)

Competency: Evaluate the importance of self-esteem as an employability skill

Competency Builders:

Identify factors that affect self-esteem
Compare effects of low self-esteem and high self-esteem
Identify strategies to promote positive self-esteem

Competency: Demonstrate job retention skills

Competency Builders:

Identify employer expectations regarding job performance, work habits, attitudes, personal appearance, and hygiene
Exhibit appropriate work habits and attitude
Demonstrate ability to set priorities
Identify behaviors to establish successful working relationships
Identify alternatives for dealing with harassment, bias, and discrimination based on race, color, national origin, sex, religion, handicap, or age
Identify opportunities for advancement
List reasons for termination
List consequences of being absent frequently from job
List consequences of frequently arriving late for work
Demonstrate interpersonal relations skills (i.e., verbal and written)
Demonstrate negotiation skills
Demonstrate teamwork
Follow chain-of-command
Exhibit appropriate job dedication

Competency: Demonstrate knowledge of work ethic

Competency Builders:

Define work ethic
Identify factors that influence work ethic
Differentiate law and ethics
Describe how personal values are reflected in work ethic
Describe how interactions in the workplace affect personal work ethic
Describe how life changes affect personal work ethic

Competency: Exhibit appropriate work ethic

Competency Builders:

Use time-management techniques
Avoid personal activity during work hours
Attend work as scheduled
Adhere to company and/or governmental policies, procedures, rules, and regulations
Exercise confidentiality
Demonstrate appropriate human relations skills
Adhere to rules of conduct
Accept constructive criticism
Offer constructive criticism
Take pride in work
Resolve conflict
Manage stress
Avoid sexual connotations and harassment
Adjust to changes in the workplace
Demonstrate punctuality
Assume responsibility for personal decisions and actions
Take responsibility for assignments
Follow chain-of-command

Competency: Apply decision-making techniques

Competency Builders:

Identify decision to be made
Identify ownership of decision to be made
Identify possible alternatives and their consequences
Make decisions based on facts, legality, ethics, goals, and/or culture
Apply time factor(s)
Present decision to be implemented
Evaluate decision made
Take responsibility for decision

Competency: Apply problem-solving techniques

Competency Builders:

Identify problem
Select appropriate problem solving tools/techniques
Identify root problem cause(s)
Track root problem cause(s)
Identify possible solutions and their consequences (e.g., long term, short term, crisis)
Use resources to explore possible solutions to problem
Contrast advantages and disadvantages of each solution
Identify appropriate action
Evaluate results
Identify post-preventive action

Competency: Exhibit characteristics for job advancement

Competency Builders:

Display positive attitude
Demonstrate knowledge of position
Perform quality work
Adapt to changing situations and technology
Demonstrate capability/responsibility for different positions
Identify characteristics of effective leaders
Identify opportunities for leadership in work place/community
Demonstrate initiative to affect change in workplace
Participate in continuing education/training program
Responds appropriately to criticism from employer, supervisor, or other employees
Exhibit awareness of corporate culture
Prepare for job setbacks
Exhibit continual growth based on performance evaluation
Set realistic goals

Unit: Professionalism

Competency: Project professional image

Competency Builders:

Define professionalism
Exhibit professional appearance
Exhibit professional manners
Project professional attitude
Identify individuals' vital role in organization
Exhibit proper etiquette in professionally-related situations

Competency: Achieve individual and professional goals

Competency Builders:

Set flexible, realistic, and measurable goals
Identify potential barriers to achieving goals
Identify strategies for addressing barriers to goal achievement
Breakdown long-term goals into short-term goals
Prioritize goals
Commit to goals
Adjust goals
Obtain support for goals
Reward goal achievement

Competency: Manage personal finances

Competency Builders:

Explain need for personal management records
Balance checkbook
Identify tax obligations
Analyze how credit affects financial security
Compare types and methods of investments
Compare types and methods of borrowing
Compare types and methods of insurance
Compare types of retirement options/plans
Identify discriminatory vs. non-discriminatory expenditures

Competency: Support community well-being

Competency Builders:

Identify environmental, educational, and social issues
Participate in social and/or community activities

Competency: Achieve organizational goals

Competency Builders:

Evaluate personal goals in relation to organizational goals
Monitor progress by evaluating feedback
List responsibilities in relation to organization goals
Accomplish assigned tasks
Exercise responsibility in relation to organizational goals
Set appropriate personal performance standards
Communicate goals with supervisor and peers
Demonstrate knowledge of products and services
Promote organizational image and mission

Competency: Demonstrate positive relations in the workplace

Competency Builders:

Identify personality types of self and other
Identify various management styles
Support employer expectations
Support employer decisions
Accept constructive criticism
Give constructive feedback
Adapt to changes in workplace
List factors to consider before resigning
Write letter of resignation

Competency: **Manage stressful situations**

Competency Builders:

Accept stress as part of daily life
Identify personal and professional factors contributing to stress
Describe physical and emotional responses to stress
Evaluate positive and negative effects of stress on productivity
Identify strategies for reducing stress
Implement strategies to manage stress
Create strategies for developing and maintaining support systems

Competency: **Analyze effects of family on work and work on family**

Competency Builders:

Identify how family values, goals, and priorities are reflected in work place
Identify responsibilities and rewards associated with paid and non-paid work
Identify responsibilities and rewards associated with families
Explain how family responsibilities can conflict with work
Explain how work can conflict with family responsibilities
Explain how work-related stress can affect families
Explain how family-related stress can affect work
Identify family support systems and resources
Identify work-related support systems and resources
Communicate with family regarding work

Competency: **Apply lifelong learning skills**

Competency Builders:

Define lifelong learning
Identify factors that cause need for lifelong learning
Analyze effects of change
Identify reasons why goals change
Describe importance of flexibility and adaptability
Evaluate need for continuing education/training

Competency: Manage professional development

Competency Builders:

Identify career opportunities
Modify career plan
Participate in continuing education/training opportunities
Document continuing education/training
Read profession-related manuals, technical journals, and periodicals
Attend meetings, workshops, seminars, conferences, and demonstrations
Participate in professional organizations
Build personal/professional mentor relationship
Build personal/professional support system
Build professional network
Strengthen communication skills
Strengthen leadership skills
Strengthen management skills

Unit: Teamwork

Competency: Demonstrate knowledge of teamwork

Competency Builders:

Define empowerment
Differentiate work groups and teams
Identify conditions essential to teamwork (e.g., brainstorming)
Explain influence of culture (e.g., corporate, community) on teamwork
Identify appropriate situations for using teams
Define team structures (e.g., cross functional, quality improvement, task force, quality circles)
Identify team building concepts
Describe characteristics and dynamics of teams
Identify characteristics of effective team leaders and members
Identify responsibilities of a valuable team member
Identify methods of involving each member of a team
Explain how individuals from various backgrounds contribute to work-related situations (e.g., technical training, cultural heritage)
Explain the purpose of facilitators
Define consensus
Define reward/recognition system

Competency: Demonstrate teamwork

Competency Builders:

Identify purpose of team and intended goal (include time frames)
Structure team around purpose
Define responsibilities of team members
Contribute to efficiency and success of team
Work toward individual and team milestones
Analyze results of team project
Facilitate a team meeting
Assist team member(s) with problem
Monitor time frame
Stress continuous improvement
Accept failure as part of learning

Competency: **Use teamwork to solve problems**

Competency Builders:

Identify appropriate situations for using teams
Use problem-solving process in a team setting
Identify quality management processes/techniques
Identify quality assurance processes/techniques
Prepare presentation

Competency: **Conduct team meetings**

Competency Builders:

Plan agenda
Schedule meeting and location
Invite appropriate personnel
Solicit outside speakers as needed
Assign someone to take minutes
Facilitate introductions
Invite questions and comments and group participation
Focus team on agenda items
Assign appropriate action, time frame and accountability to tasks
Monitor time
Close meeting on time
Publish minutes in timely manner
Set ground rules
Avoid placing individual agendas above the group's agenda

Unit: Quality Assurance

Competency: Demonstrate knowledge of quality assurance

Competency Builders:

Explain the historical evolution of quality assurance (e.g., Deming, ISO 9000)
Explain changes brought about by quality leaders in the world
Explain the ISO 9000 process
Define quality terms
Define quality functions
Identify features of quality planning
Describe control devices used in functional areas (e.g., SPC, equipment)
Explain the relationship among organizational structures, policies, procedures, and quality assurance
Explain importance of internal and external customers
Identify internal and external customers
Describe successful efforts by industry to improve quality and/or reduce costs
Differentiate prevention and detection
Differentiate variable and attribute data
Identify types of coontrol charts
Explain how statistical techniques are tools used to control quality (e.g., SPC, DOE, CR)

Competency: **Demonstrate knowledge of quality cost implications**

Competency Builders:

Identify cost/quality objectives
Classify costs (i.e., direct and indirect, fixed and variable, methods and standards)
Classify quality costs (i.e., prevention, evaluation, pre-delivery failure, post-delivery failure)
Define produce liability
Interpret quality cost reports
Explain consumerism and liability prevention
Define safety terms of product
Identify safety responsibility within organization
Define contracts and torts
Differentiate express and implied warranty
Differentiate warranty and product liability
Explain how warranties are part of contract law
List questions that would need answering in liability claim

Competency: **Demonstrate knowledge of engineering a quality product**

Competency Builders:

Associate customer satisfaction with product characteristics (e.g., usefulness, price, operation, life, reliability, safety, cost of operation)
Define manufacturability
Identify steps in product design (e.g., brainstorming, thumbnail sketches, rendering)
Define reliability factors (e.g., cost, human, producibility)
Identify ways reliability is achieved (e.g., maintainability, good design, design simplification, design redundancy)
Explain the relationship of maintainability to reliability
Define failure
Explain the role of testing and reliability
Define value engineering
Define quality objectives
Identify cost components as they relate to quality objectives
Classify quality costs (i.e. preventive, evaluation, pre-delivery failures, post delivery failures)
Describe predictive maintenance

Competency: **Explain importance of interdepartmental relationships to quality assurance**

Competency Builders:

Explain need for everyone's commitment in assuring quality
Explain phrase "Everyone is a customer/supplier"
Define quality improvement team models
Explain the importance of top management's support of quality
Explain project selection
Explain project implementation
Explain project evaluation
Explain continuing improvement
Describe future trend of experiment design
Describe future trend of predictive maintenance

Competency: **Manipulate quality cost data**

Competency Builders:

Develop quality cost data
Translate cost reports
Graph quality cost data (e.g., pareto)

Competency: **Manipulate cost control data**

Competency Builders:

Develop cost control data
Analyze cost control reports
Provide cost control data
Provide advice on "Make or Buy" decisions (including economical lot size decisions)

Competency: Demonstrate knowledge of basic statistics

Competency Builders:

Describe data collection methods
Collect data
Organize data by flow chart
Interpret data by cause and effect diagrams
Define nominal, ordinal, interval, and ratio data
Define mean, median, and mode
Explain significance of standard deviation
Explain normal distribution

Competency: Demonstrate knowledge of scattergrams

Competency Builders:

Construct scattergram
Interpret for positive, negative, or no correlation between X and Y variables
Test for significance between one and five percent
Explain regression analysis

Competency: Demonstrate knowledge of probability theory

Competency Builders:

Define classical probability
Define empirical probability
Calculate probability for outcomes

Competency: Demonstrate knowledge of precontrol

Competency Builders:

Explain uses of precontrol
Calculate precontrol limits
Explain significance of the limits
Plot values on a precontrol chart
Explain "out-of-control" situation
Make decisions on green, yellow and red conditions

Competency: Demonstrate knowledge of process capability

Competency Builders:

Use X, R, USL, and LSL to determine process capability (upper and lower specification limits)
Calculate estimated process standard deviation
Plot right hand and left hand tail of process variation
Compute Z value for percent of probable defect for process
Calculate C_{PK} values that describe process capability
Describe skewed distributions
List probable causes of skewed distribution

Competency: Use quality control charts

Competency Builders:

Identify operational definitions for attribute criteria
Interpret histogram
Interpret scattergrams
Interpret NP chart
Interpret P chart
Interpret flowchart
Interpret cause-and-effect diagram
Construct P (percentage defective) chart for attributes
Plot control limits of P chart and data points
Check chart for out-of-control conditions
Construct an NP (number defective) chart with control limits and data
Construct C (count of defects) and U (number of defects per unit) charts
Check data on C and U charts
Construct flowchart
Construct cause-and-effect chart

Competency: Interpret $\bar{X}$ and R charts

Competency Builders:

Plot percentages for normal distribution
Test distribution for normality
Explain difference between common cause and special cause
Define an "in-control" process
Explain significance of an out-of-control point on $\bar{X}$ or R chart
Identify patterns and trends on control chart
Identify run up and run down
Test for middle third on control chart
Explain significance of middle third on control chart
Explain Rule of Sevens

Competency: Construct $\bar{X}$ and R charts

Competency Builders:

Arrange data into statistical sub-groups
Explain importance of random sampling
Compute $\bar{X}$ (i.e., average of values) and R (i.e., range of values in subgroup) within sample
Plot in $\bar{X}$ and R on chart
Construct control chart with $\bar{\bar{X}}$ (grand average) and R (average range) calculated
Calculate upper and lower control limits for $\bar{X}$-chart
Calculate upper and lower control limits for R-chart

Competency: Conduct process improvement studies

Competency Builders:

Analyze production methods and processes applying statistical process improvement techniques (e.g., SPC, C_{PK})
Identify appropriate statistical techniques for study (e.g., T-tests, F-test, capability, DOEX)
Identify major steps in conducting a study
Define "report" for a study (e.g., goal, objective, study conduct, results, conclusions, discussions)
Integrate results into the total system

Competency: **Demonstrate knowledge of JIT**

Competency Builders:

Define just-in-time concept (JIT)
Describe various production methodologies (e.g., standard cycle times, routings, standard quantities, multiple-machine tending)
Describe types of inventory control (e.g., Kanban)
Describe importance of flexibility
Differentiate product layout, process layout, fixed position layout, and cellular layout
Differentiate straight-line, U-shaped, S-shaped, convoluted and comb patterns
Describe advantages/disadvantages of layout and patterns
Explain importance of product protection, identification and storage
List methods of identifying products (e.g., labels, bar codes, radio frequency systems and magnetic strip systems)
Describe manual methods of storage and retrieval
Describe automated storage and retrieval systems (ASRS)
Describe automated guided vehicle moving systems (AGVS)

Competency: **Apply JIT**

Comptency Builders:

Maintain system for physical handling and movement of material in-process and in-storage
Monitor system of physical handling and movement of material in-process and in-storage
Maintain system for physical handling and movement of finished products
Monitor system of physical handling and movement of finished products
Write requests for deviation from specifications
Implement quality control and inspection standards and procedures
Write engineering change notices and rejection reports
Monitor reports of discrepancy or rejects during production process
Conduct quality tests under different environmental conditions

Competency: Demonstrate knowledge of inspection

Competency Builders:

Explain purpose of inspection
Describe scope of inspection
Explain purpose of incoming, ongoing, and final inspections
Explain early detection inspection
Explain how statistical process control (SPC) aids inspection
Define types of nonconformance
Define degrees of nonconformance
Define corrective action
Describe when to 100% inspect
Describe when to sample inspect
Describe methods of testing for material properties (e.g., harness, strength, chemical makeup, flaws, errors in tooling or setup)
Define rework, salvage, and scrap
Describe ethical decisions an inspector may make
Identify purposes of computer-automated inspection
Explain advantages and limitations of automated inspection
Explain disposition of non-conforming material
Explain basic foolproofing concept to build inspection into process (i.e., poka-yoke)
Use checksheets to organize and record inspection results

Competency: Inspect machinery, materials, and products

Competency Builders:

Identify critical material characteristics from specification(s) or drawing(s)
Perform capability studies for machinery and materials acceptance
Identify appropriate acceptance sampling plan
Conduct incoming materials inspection using sampling plan criteria
Identify critical in-process characteristics from specification(s) or drawing(s)
Demonstrate basic metrology skills
Conduct in-process inspection
Identify appropriate inspection reports and follow-up
Gauge R and R (reproducibility and repeatability)
Apply geometric tolerancing
Explain C = O (zero) acceptance plan
Interpret instructions in a control plan

Competency: Demonstrate knowledge of nondestructive testing

Competency Builders:

Describe purpose of nondestructive testing
Identify anomalies
Define defects and discontinuities
Identify factors contributing to defects and discontinuities
Describe ultrasonic testing
Describe advantages and limitations of ultrasonic testing
Describe industrial radiography
Compare use of wet and dry particles in magnetic particle inspection
Explain advantages and limitations of penetrant inspection
Describe microwave testing
Describe holographic inspection
Explain choice of most suitable nondestructive test method
Describe eddy-current testing

Unit: Technical Recording and Reporting

Competency: Demonstrate proficiency in technical recording

Competency Builders:

Describe various documentation procedures
Interpret specifications or drawings
Observe process
Ask open-ended questions
Record process (e.g., flowchart, step-by-step)
Identify parameters
Record accurate, truthful data
Maintain test logs
Compile cumulative reference notebook/record
Measure appropriate parameters
Draft preventive maintenance and calibration procedures

Competency: Demonstrate proficiency in technical reporting

Competency Builders:

Use data books and cross reference/technical manuals
Compose technical memoranda
Identify type of report or format needed
Use appropriate format
Compile relevant data
Design charts and graphs
Analyze data
Draw conclusions
Explain analytical methods used
Outline reports
Write reports
Present reports

Unit: Computer Literacy

Competency: Describe personal computer operations

Competency Builders:

Explain how data is stored in main computer memory
Explain how computer system executes program instruction
Explain computer storage capacity
Explain how data is represented
Describe data storage techniques
Identify types of memory

Competency: Explain information processing cycle

Competency Builders:

Define operating systems (e.g., DOS, OS/2, UNIX, MAC)
Describe computer languages and their use
Describe computer languages and their use
Describe computer languages and their use
Describe difference between data files and program files
Explain PC layout
Explain PC network layout
Explain mini/mainframe network layout
Differentiate hardware and software
Differentiate open from proprietary architecture

Competency: Operate computer hardware

Competency Builders:

Practice proper media handling techniques (e.g., magnetic fields, dust, liquids)
Identify hardware and its use
Use hardware (e.g., mouse, diskettes, drive, modems, touch screen, printers, digitizers, scanners, cables, protection devices)
Keyboard efficiently
Demonstrate basic care of hardware
Explain need for and application of security levels/procedures
Perform basic hardware troubleshooting
Explain hardware addressing techniques

Competency: Use software

Competency Builders:

Define software types and functions
Describe basic disk operations and care
Perform functions necessary to operate software
List advantages and disadvantages of integrated and dedicated software
Operate system software
Operate diagnostic software
Demonstrate basic proficiency in spreadsheet use
Demonstrate basic proficiency in word processing
Demonstrate basic proficiency in database use
Demonstrate basic proficiency in network use
Demonstrate basic proficiency of utility (e.g., WINDOWS, GUI)
Demonstrate basic proficiency in report writing
Demonstrate system commands
Differentiate ethical use/misuse of software
Describe bulletin boards/electronic mail
Apply security levels/procedures while handling sensitive data
Explain data compression techniques
Explain use and deletion of passwords

Unit: Workplace Safety

Competency: Apply general safety precautions

Competency Builders:

Identify local, state, and federal rules and regulations
Identify personal protective wear and equipment
Identify visual controls (e.g., monitors, read outs)
Identify auditory controls
Identify common sense housekeeping
Interpret hazardous materials notices on containers
Use personal protective wear and equipment
Apply workplace safety rules and procedures
Apply personal safety rules and procedures
Apply workplace organization (e.g., housekeeping)
Apply applicable electrical, mechanical, steam, hydraulic and (e.g., pneumatic safety rules and procedures)
Apply fire safety rules and procedures
Apply hazardous wastes rules and procedures
Apply first aid
Locate (MSDS)
Perform lockout and tagout
Recycle scrap metal, chips, shavings, coolants, solvents, trash, and waste materials
Apply common sense housekeeping
Use preventive maintenance checklists

Competency: **Demonstrate knowledge of safety and workplace hazards**

Competency Builders:

Describe corrective procedures for unsafe conditions
Identify types and potential level of workplace hazards (e.g., physical hazards, fire, chemicals, noise, ionizing radiation, ultraviolet, temperature extremes, ergonomics, biological hazards)
Identify safety materials/equipment (e.g., absorbant socks, oil dry)
Interpret Material Safety Data Sheets (MSDS)
Explain purpose(s) of OSHA and NIOSH
Explain purpose(s) of NEC and NFPA
Identify purpose of emergency evacuation routes, master switch and lockout locations, and safety color coding systems
Identify roles of industrial hygienists, safety professionals, occupational physicians, and occupational nurses
Describe methods of evaluating potential hazards (e.g., visual analysis)
Describe methods of correcting potential hazards
Describe various types of toxicity (e.g., chronic, immediate)
Identify need for reporting accidents
Explain precautions required when using toxic or flammable materials
Define confined space and related requirements
Explain how international directives relate to safety

Competency: **Explain purpose of industrial pollution control systems**

Competency Builders:

Describe types of air, water, solid waste, and noise pollution
Explain purpose of air pollution control systems
Explain purpose of water pollution control systems
Explain purpose of solid waste pollution control systems
Explain purpose of noise pollution control systems
Explain basic philosophy of "right to know" legislation
Explain purpose(s) of EPA
Identify "costs" of industrial pollution control (i.e., dollars vs. impact to environment)
Describe ethics of environmental issues

Competency: Demonstrate knowledge of ergonomics

Competency Builders:

Define ergonomics
Define risk factor
Define maximum permissible limit (MPL) and action limit (AL) for lifting
Define cumulative trauma disorder (CTD)
Identify susceptibility factors for CTD
Minimize extreme joint movement
Minimize use of excessive muscle force
Minimize repetitive tasks
Minimize mechanical stresses (e.g., sharp edges, heat, cold, hard surfaces, weights, vibration)
Minimize awkward body positions
Explain use of rest pauses
Explain need for mats and footrest for standing jobs
Explain need for appropriate working heights of chairs, stools, workbenches, equipment
Explain need for adequate lighting
Explain use of anthropometric (i.e., centering one's view of everything around man) design

Unit: Basic Electronics

Competency: **Demonstrate proficiency in electronics fundamentals**

Competency Builders:

Identify electronic components and schematic symbols
Describe basic atomic structure and its relationship to electricity
Describe the relationship between electrical and magnetic properties
Describe the electrical and magnetic properties of a magnet
Describe the photoelectric effect
Describe the thermocouple effect
Describe the electrical effect of friction
Use metric units to solve electronic unit problems
Identify sources of electricity
Describe principles and operations of electrochemical supplies
Describe voltage, current, resistance, power, and energy
Apply Ohm's Law
Apply Kirchoff's Laws
Apply power formulas
Explain Thevenin's Theorem
Explain Norton's Theorem
Interpret color codes and symbols to identify electrical components and values
Measure properties of circuits using test equipment
Describe electrostatic discharge (ESD) procedures

Competency: Demonstrate proficiency in DC circuits

Competency Builders:

Compute conductance of conductors and insulators
Measure resistance and current of conductors and insulators
Measure properties of a circuit using volt-ohm meter (VOM) and digital volt-ohm meter (DVM)
Build series, parallel, and combination circuits
Build bridge circuits
Build voltage divider circuits (loaded and unloaded)
Compute voltage divider circuits (loaded and unloaded)
Demonstrate maximum power transfer theory
Describe magnetic properties of circuits and devices
Explain physical and electrical characteristics of capacitors and inductors
Describe RC and RL time constants
Compute RC and RL time constants
Demonstrate use of diodes in DC circuits
Identify need for rectification
Operate power supplies for DC circuits
Analyze frequency spectrums
Construct the operation of DC circuits that demonstrate maximum power transfer theory
Use meters and oscilloscopes
Measure current, voltage, and resistance in DC circuits
Explain simple DC generator action
Explain simple DC motor action
Explain principals of solid-state switching devices
Solve algebraic problems to include exponential (prerequisite to DC) (algebraic calculation)
Explain use of DC in relation to communications
Identify classes, voltage ratings and/or polarity of electronic components
Identify use of circuit protective devices (e.g., fuses, breakers)
Troubleshoot DC circuits

Competency: Demonstrate proficiency in AC circuits

Competency Builders:

Analyze properties of an AC signal
Describe principles and operation of characteristics of sinusoidal and non-sinusoidal wave forms
Identify AC sources
Describe principles and operation of characteristics of capacitive circuits
Operate capacitive circuits
Describe principles and operation of characteristics of inductive circuits
Operate inductive circuits
Describe principles and operation of transformers
Demonstrate operation of AC circuits utilizing transformers
Use maximum power transfer theorems
Use Thevenin's and Norton's theorem to analyze AC circuits
Measure power in AC circuits
Operate capacitor and inductor analyzers for AC circuits
Operate differentiators and integrators to determine RC and RL time constants
Describe principles and operation of characteristics of series and parallel resonant circuits
Build series and parallel resonant circuits
Identify classes, voltage, ratings and/or polarity of electronic components
Identify use of circuit protective devices (e.g., fuses, breakers)
Describe principles and operation of characteristics of frequency selective filter circuits
Calculate logarithmic to obtain gain (dB) using tables or calculator/computer
Operate frequency selective filter circuits
Operate polyphase circuits
Describe basic motor theory and operation
Describe basic generator theory and operation
Operate power supplies for AC circuits
Describe principles and operation of various power conditioning (e.g., isolation transformers, surge suppressors, uninterruptable power systems)
Describe principles and operation of various safety grounding systems (e.g., lightning arresters, ground electrostatic discharge, fault interrupters, etc.)
Describe characteristics of inductors in series and parallel circuits
Describe characteristics of capacitance in series and parallel circuits
Compare resistive-capacitive (RC) and resistive-inductive (RL) time constants (TC)
Measure voltage, current, time, frequency (f), and phase relationships of AC sine wave signal
Describe frequency (F) and phase relationships

Competency: **Demonstrate proficiency in C circuits (CONTINUED)**

Competency Builders:

Describe resonance of inductive-capacitive (LC) circuits
Calculate impedance match and maximum transfer of power
Measure current, voltage, and resistance in AC circuits
Identify 50/60 Hertz
Explain simple AC generator action
Explain simple AC motor action
Calculate power factor in AC circuits
Explain harmonics and its effects on power quality
Solve basic trigonometric problems as applicable to electronics
Calculate peak (PK), root mean square (RMS), and average values
Troubleshoot AC circuits

Unit: Fundamentals of Electronics Technology

Competency: **Demonstrate proficiency in discrete solid-state devices**

Competency Builders:

Describe properties of semiconductor materials
Describe operating characteristics and applications of PN junctions
Demonstrate operation of diode circuits
Troubleshoot diode circuits
Repair diode circuits
Describe operating characteristics and applications of bipolar transistors
Describe operating characteristics and applications of field effect transistors
    (e.g., FET + s/MOSFET + s)
Describe operating characteristics and application of special diodes/transistors
Describe operating characteristics and applications of opto-electronic devices
    (e.g., gate isolators, interrupt sensors, infrared sensors)
Describe operating characteristics and applications of single-stage amplifiers
Demonstrate the operation of the single-stage amplifiers
Troubleshoot single-stage amplifiers
Repair single-stage amplifiers
Demonstrate the operation of thyristor circuitry (SCR, TRIAC, DIAC, etc.)
Troubleshoot thyristor circuitry (SCR, TRIAC, DIAC, etc.)
Operate analog and digital equipment for solid-state devices
Operate power supplies for solid-state devices
Operate oscilloscopes for solid-state devices
Operate function generators for solid-state devices
Operate curve tracers
Operate transistor testers

Competency: Demonstrate proficiency in analog circuits

Competency Builders:

Operate measuring instruments for analog circuits
Describe operating characteristics and applications of linear integrated circuits
Describe operating characteristics and applications of power supplies and filters
Describe operating characteristics and applications of operational amplifier circuits
Demonstrate the operation of operational amplifier circuits
Describe the operating characteristics and applications of regulated and switching power supply circuits
Demonstrate the operation of regulated power supply circuits
Describe operating characteristics and applications of active filters
Demonstrate the operation of active filter circuits
Describe operating characteristics and applications of sinusoidal and non-sinusoidal oscillator circuits
Demonstrate the operation of oscillator circuits
Describe the operating characteristics and applications of motor phase-shift control circuits (single-phase and multi-phase)
Describe the operating characteristics and applications of cathode ray tubes

Competency: Demonstrate proficiency in digital circuits

Competency Builders:

Operate logic problems for digital circuits
Operate power supplies for digital circuits
Operate pulsers for digital circuits
Operate oscilloscopes for digital circuits
Describe characteristics of integrated circuit (IC) logic families
Describe the principles and operation of types of logic gates and their truth tables
Demonstrate the use of logic gates
Describe the principles and operation of combinational logic circuits
Demonstrate the operation of combinational logic circuits
Describe the principles and operation of numbering systems, codes, and arithmetic operations
Minimize logic circuits using Boolean operations
Describe the principles and operation of types of flip-flops
Demonstrate the operation of flip-flops
Describe the principles and operation of types of registers and counters
Demonstrate the operation of registers and counters
Describe the principles and operation of clock and timing circuits
Demonstrate the operation of clock and timing circuits
Describe the principles and operation of types of arithmetic-logic circuits
Demonstrate the operation of arithmetic-logic circuits
Describe the principles and operation of types of encoders and decoders
Demonstrate the operation of encoders and decoders
Describe the principles and operation of types of multiplexer and demultiplexer circuits
Demonstrate the operation of multiplexer and demultiplexer circuits
Describe the principles and operation of digital-to-analog and analog-to-digital circuits
Demonstrate the operation of digital-to-analog and analog-to-digital circuits
Describe the principles and operation of types of digital display circuits
Demonstrate the operation of digital display circuits
Describe the types of digital display devices
Demonstrate the operation of digital display devices
Describe the operating characteristics and applications of fiber optics
Demonstrate the operation of fiber optics

Competency: Demonstrate basic proficiency in microprocessors

Competency Builders:

Describe the essential components of a microprocessor and their functions
Identify the levels of computer languages
Operate oscilloscopes and logic/data analyzers
Describe the principles and operation of BUS concepts
Describe the principles and operation of types of memory circuits
Demonstrate the operation of memory circuits
Troubleshoot memory circuits
Repair memory circuits
Describe microprocessor instruction sets
Describe the principles and operation of microprocessor machine code
Demonstrate the use of microprocessor machine code
Debug microprocessor machine code
Interface various types of peripherals
Describe the use of microprocessor simulator(s)

Competency: Describe manufacturing of electronic devices and micromechanisms

Competency Builders:

List properties of electronic packaging materials
Describe manufacturing of electronic products chips; integrated circuits; printed integrated circuits
Describe joining and assembly of electronic components
Describe coating and etching processes
List principles of packaging electronic components
Describe manufacture of miniature devices
Describe testing of joints
Describe reliability of electronic product testing
Describe the advantages and disadvantages of various advanced packaging techniques (e.g., SMD, MCM)
Describe methods of fabrication

Unit: Troubleshooting and Repair

Competency: Demonstrate troubleshooting skills

Competency Builders:

Explain role of preventive maintenance
Differentiate normal and abnormal operations
Explain troubleshooting procedures
Explain logical actions taken to troubleshoot
Use proper troubleshooting aids
Demonstrate knowledge of safety rules for troubleshooting and repair procedures
Maintain troubleshooting and repair records
Interpret prints (e.g., PID, loopsheets)
Use manufacturer's manuals, schematics, and troubleshooting charts
Isolate faults, shorts, and open circuits

Competency: Apply troubleshooting techniques to DC circuits

Competency Builders:

Identify noise problems
Isolate faults in series, parallel and series parallel
Isolate faults in bridge circuits
Isolate faults in DC power supplies
Perform polarity check
Isolate faults to DC drive system
Isolate faults in voltage divider circuits
Repair faults

Competency: **Apply troubleshooting techniques to AC circuits**

Competency Builders:

Isolate faults in capacitive circuits
Isolate faults in inductive circuits
Isolate faults in AC circuits utilizing transformers (e.g., step up and step down)
Isolate faults in differentiator and integrator circuits
Isolate faults in RC, RL, and RLC circuits
Isolate faults in frequency selective filter circuits
Isolate faults to AC frequency drive systems
Repair faults

Competency: **Apply troubleshooting techniques in discrete solid-state devices**

Competency Builders:

Isolate faults in diode circuits
Isolate faults in thyristor circuitry (e.g., SCR, TRIAC, DIAC)
Isolate faults in transistor circuits
Isolate faults in operational amplifier circuits
Isolate faults in single-stage amplifiers
Isolate faults in open circuits
Repair faults

Competency: **Apply troubleshooting techniques to analog circuits**

Competency Builders:

Isolate faults in single and multistage amplifiers
Isolate faults in audio power amplifiers
Isolate faults in regulated and switching power supply circuits
Isolate faults in active filter circuits
Isolate faults in oscillator circuits
Isolate faults in operational amplifier circuits
Isolate faults in power supplies (loaded and unloaded) and filters
Repair faults

Competency: **Apply troubleshooting techniques to digital circuits**

Competency Builders:

Identify noise problems
Isolate faults in multiplexer and demultiplexer circuits
Isolate faults in digital display circuits
Isolate faults in logic gates
Isolate faults in flip-flops
Isolate faults in registers and counters
Isolate faults in clock and timing circuits
Isolate faults in arithmetic-log circuits
Isolate faults in encoders and decoders
Isolate faults in digital-display devices
Repair faults

Competency: **Apply troubleshooting techniques to a microcomputer system**

Competency Builders:

Isolate faults to systems boards
Isolate faults to memory circuits
Isolate faults to data storage devices
Isolate faults in power supplies
Troubleshoot I/O ports
Isolate faults in I/O interface circuitry
Use diagnostic software
Repair faults

Competency: **Apply troubleshooting techniques to manufacturing systems**

Competency Builders:

Identify individual process blocks of assembly line or process
Identify process block interfaces
Demonstrate steps required for efficient systems troubleshooting
Isolate system faults to process block
Isolate block faults using schematics
Isolate block faults using programmable controller indicators
Isolate block faults using volt meter
Repair block faults by replacing fault component or wiring

Unit: Microcomputer Electronics Technology

Competency: **Demonstrate basic proficiency in microprocessor systems**

Competency Builders:

Describe essential components of microprocessor and their functions
Describe principles and operation of BUS concepts (e.g., VESA, EISA)
Describe principles and operation of types of memory circuits
Identify operating systems (e.g., DOS, OS/2, UNIX)
Describe microprocessor instructions sets
Describe principles and operation of microprocessor machine code
Demonstrate use of microprocessor machine code
Decode microprocessor machine code
Identify types of input and output devices and peripherals
Describe principles and operation of storage devices
Operate oscilloscopes and logic/data analyzers
Interface input and output ports to peripherals
Demonstrate ability to interface peripherals
Identify central processing unit building blocks and their uses
Identify the levels of computer languages

Competency: **Demonstrate basic proficiency in computer systems architecture**

Competency Builders:

Describe the principles and operation of computer system architecture
Operate computer system architecture
Repair computer system architecture
Describe the principles and operation of addresses and interrupts
Describe the principles and operation of volatile and non-volatile memory
Demonstrate the use of volatile and non-volatile memory
Repair or replace volatile and non-volatile memory
Describe the principles and operation of advanced memory techniques
Define individual system blocks
Draw systems configuration in block detail
Interpret computer acronyms
Describe priorities and interrupts at systems level
Identify direct memory access data handling system(s)
Define functions of advanced memory techniques (e.g., virtual, pipeline, cache)
Troubleshoot a microcomputer system

Competency: **Demonstrate proficiency in software fundamentals**

Competency Builders:

Load operating system software
Run operating system software
Load diagnostic software
Run diagnostic software
Construct flow charts
Analyze flow charts
Explain computer languages and their uses
Write a simple computer program
Write program documentation
Describe firmware applications
Identify the need for backup
Describe security measures
Describe virus protection

Competency: Describe elements of communication interfacing

Competency Builders:

Define common EIA, IEEE, and CCITT communication standards (e.g., EIA 232 and 485; IEEE 488)
Identify sync devices
Identify async devices
Identify types of network (e.g., token ring, ethernet)
Identify networking levels or layers
Identify protocols
Identify packet switching
Identify multiuser systems
Operate network analyze devices
Identify network analyzer devices (e.g., breakout bos, sniffers)

Competency: Describe peripheral equipment interfaces

Competency Builders:

Identify types of card and paper-tape equipment and interface controllers
Define printer types and interface controllers
Explain the operation of typical magnetic tape equipment and interface controllers
Identify disk equipment and interface controllers
Define environmental requirements for peripherals and media

Unit: Communications Electronics Technology

Competency: Describe transmission line applications

Competency Builders:

Explain power conversion
Describe principles and operation of two wire and four wire transmission lines
Describe principles and operation of coaxial cable
Describe principles and operation of microwave guide
Describe principles and operation of fiber optics

Competency: Demonstrate proficiency in transmitters and receivers

Competency Builders:

Explain the purpose of Federal Communication Commission (FCC) rules and regulations
Describe principles and operation of RF amplifiers
Describe principles and operation of modulation/demodulation (e.g., AM, FM, SSB, Fiber optic, DSSC)
Construct modulation/demodulation
Operate modulation/demodulation
Describe principles and operation of microwave and satellite communication systems
Describe principles and operation of repeater systems (e.g., trunk and fiber/scramble/data)

Competency: Describe various types of multiplexing systems

Competency Builders:

Describe principles and operation of analog multiplexing systems (e.g., CATV)
Describe principles and operation of digital multiplexing systems (e.g., T-1, fiber)
Describe principles and operation of CRT modulation

Competency: Troubleshoot transmitters and receivers

Competency Builders:

Isolate system faults in RF amplifiers
Isolate system faults in CRT modulation/demodulation circuits
Isolate system faults in RF transmitters and receivers
Isolate system faults in television modulation circuits

Competency: Demonstrate basic proficiency in data communications

Competency Builders:

Describe principles and operation of data communications, signaling systems, codes, formats and protocols
Describe principles and operation of parallel and serial ports
Describe principles and operation of synchronous and asynchronous signals
Describe principles and operation of data modems
Operate data modems
Describe principles and operation of fax machines
Describe principles and operation of types of carrier systems
Describe principles and operation of various types of networks (e.g., ethernet, token ring)
Demonstrate operation of various types of networks
Describe proper techniques for cable termination (e.g., UTP, COAX, FIBER)
Demonstrate proper techniques for cable termination

Competency: Troubleshoot data communications

Competency Builders:

Isolate system faults in data modems
Isolate system faults in various types of networks
Isolate system faults in various types of cable
Isolate system faults in various types of carrier systems

Competency: **Demonstrate basic proficiency in fiber optic communications systems**

Competency Builders:

Describe proper techniques for fiber splicing
Demonstrate proper techniques for fiber splicing
Demonstrate techniques for fiber termination
Describe basic characteristics of optics such as reflection, total reflection, and refraction
Describe characteristics and components of fiber optic cables
Describe band width and attenuation limitations for fiber optic systems
Describe technique of wavelength multiplexing in fiber optic cables
Describe characteristics of various types of light sources and light detectors used in fiber optic systems
Describe components of fiber optic transmission systems
Describe transformation of data signals into light pulses
Operate a simple fiber optic data transmission system
Describe proper techniques of fiber termination

Competency: **Demonstrate proficiency in RF systems safety**

Competency Builders:

Demonstrate safety procedures for working with RF systems antennae and support structures (e.g., towers)
Demonstrate safety procedures for working with RF systems high voltage/power supply
Demonstrate safety procedures for working with RF generators
Demonstrate safety procedures for working with RF systems in confined space

Competency: Demonstrate basic proficiency in antenna systems

Competency Builders:

Describe the principles and operation of single element antennae (e.g., 1/4 wave dipole, longwire, vertical)
Describe the principles and operation of multi-element antennae (e.g., point-to-point, broadcast)
Describe the principles and operation of impedance matching of antennae systems
Describe antennae systems measurement
Operate antennae

Unit: Electro-optic Technology

Competency: Demonstrate knowledge of light principles

Competency Builders:

Describe the characteristics of light sources
Describe radiometric and photometric quantities in the measurement of light using light meters and related equipment
Describe the properties of light
Demonstrate the properties of light
Describe maximum permissible exposure (MPE)

Competency: Demonstrate knowledge of optical systems

Competency Builders:

Describe the characteristics and properties of optical materials
Describe the use of optical components (e.g., lenses, beam splitters)
Describe the principles and operation of optical systems (e.g., ray tracing, refraction)
Demonstrate the use of optical systems (e.g., convergence, focusing, divergence)
Troubleshoot optical systems
Describe the advantages and disadvantages of fiber optics

Competency: Demonstrate knowledge of lasers

Competency Builders:

Describe the principles of laser operations (e.g., population inversion, coherence)
Describe laser classifications
Describe the principles and operation of powering and pumping lasers
Describe temporal characteristics
Describe spatial characteristics
Describe laser safety

Competency: Describe laser energy applications

Competency Builders:

Describe the principles and operation of ion lasers
Describe the principles and operation of solid lasers
Describe the principles and operation of semiconductor lasers
Describe the principles and operation of dye lasers
Describe the principles and operation of lasers in welding, cutting, and drilling
Describe the principles and operation of lasers in data recordings and manipulating
Describe the principles and operation of lasers in environmental testing and monitoring
Describe the principles and operation of lasers in nondestructive testing
Describe the principles and operation of lasers in range finding, alignment and angle testing
Describe the principles and operation of fiber optics in laser systems
Describe the principles and operation of a laser in a communication system
Describe the advantages and disadvantages of fiber optics
Describe the principles of using lasers in medicine
Describe the principles of using lasers in holography/interferometry

Competency: Perform laser applications

Competency Builders:

Demonstrate the operation of various ion lasers
Demonstrate the operation of solid lasers
Demonstrate the operation of semiconductor lasers
Demonstrate the operation of dye lasers
Demonstrate CW and pulsed operation
Demonstrate the use of lasers in welding, cutting, and drilling
Demonstrate the use of lasers in data recording and manipulating
Demonstrate the use of lasers in environmental testing and monitoring
Demonstrate the use of lasers in nondestructive testing
Demonstrate the use of lasers in range finding, alignment and angle testing
Demonstrate the use of a laser communication system
Troubleshoot laser applications
Repair laser applications

Unit: Electronic Product Servicing Technology

Competency: **Demonstrate proficiency in surface mounted devices**

Competency Builders:

Describe the principles and operation of types of surface mounted devices (SMDs) for DC, AC and solid-state circuits
Describe the proper procedure for handling static sensitive devices
Locate defective SMDs using appropriate troubleshooting techniques
Replace SMDs using appropriate troubleshooting techniques

Competency: **Demonstrate proficiency in radio and television receiving systems**

Competency Builders:

Interpret radio and television receiving system block diagrams
Describe the principles and operation of a superhetrodyne receiver
Construct a superhetrodyne receiver
Align a superhetrodyne receiver
Troubleshoot a superhetrodyne receiver
Repair a superhetrodyne receiver
Describe the principles of video signal generation
Describe the principles and operation of TV circuits
Troubleshoot TV circuits
Repair TV circuits
Perform operating systems check to radio and television receiving systems
Adjust radio and television systems
Describe High Definition Television systems
Operate video analyzers
Operate National Television Signal Codes (NTSC) generators
Operate cathode ray tube (CRT) analyzers
Operate stereo generators

Competency: **Demonstrate proficiency in video recording and playback systems**

Competency Builders:

Describe characteristics associated with recording and playback systems
Interpret video recording system block and circuit diagrams
Identify operational status of video recording systems (mechanical and electronic)
Perform operating systems check to video recording systems
Adjust video recording systems
Describe the operating characteristics and application of BETA, VHS and 8mm test equipment
Demonstrate the operating characteristics and application of BETA, VHS and 8mm test equipment
Operate vectorscopes and wave form monitors
Describe the operating characteristics and application of BETA, VHS and 8mm recorders and playback systems
Describe the operating characteristics and application of camcorders
Demonstrate the operating characteristics and application of camcorders
Troubleshoot video recording systems
Repair video recording systems
Describe electronic chemicals (e.g., solvents, lubricants, anticorrosives)

Competency: **Demonstrate proficiency in laser disc systems**

Competency Builders:

Describe characteristics associated with laser disc systems
Interpret laser disc system blocks and circuit diagrams
Describe the operation of laser disc systems
Demonstrate the operation of laser disc systems
Describe the principles and operation of interactive video
Troubleshoot laser disc systems
Repair laser disc systems

Demonstrate proficiency in computer systems

Competency Builders:

Describe the principles and operation of computer system architecture
Demonstrate the operation of computer system architecture
Describe the principles and operation of addresses and interrupts
Demonstrate the use of addresses and interrupts
Describe the principles and operation of volatile and non-volatile memory
Demonstrate the use of volatile and non-volatile memory
Describe the principles and operation of advanced memory techniques
Demonstrate the use of advanced memory techniques
Troubleshoot computer systems
Repair computer systems

Competency: Demonstrate proficiency in home electronics systems

Competency Builders:

Describe characteristics associated with home automation systems (e.g., computers and peripherals)
Interpret home automation systems block and circuit diagrams
Describe the operation of home automation systems
Replace home automation systems
Describe the principles and operation of fax machines
Demonstrate the operation of fax machines
Describe the principles and operation of personal computer games
Demonstrate the operation of personal computer games
Describe characteristics associated with electronic security systems
Describe the installation of an electronic security systems
Demonstrate the operation of electronic security systems
Troubleshoot home electronics systems
Repair home electronics systems (e.g., replace and align electronic components)

Competency: Demonstrate proficiency in audio systems

Competency Builders:

Describe the principles and operation of audio systems
Interpret audio systems block and circuit diagrams
Demonstrate the operation of audio systems
Describe the principles and operation of digital audio tape (DAT)
Describe the principles and operation of digital compact cassette (DCC)
Troubleshoot audio systems
Repair audio systems (e.g., replace audio components)

Competency: Demonstrate proficiency in antenna systems (CATV/SATV)

Competency Builders:

Describe the principles and operation of antennae systems
Demonstrate the installation of antenna systems
Describe the principles and operation of a CATV system
Demonstrate the operation of a CATV system
Describe the principles and operation of a SATV system
Demonstrate the operation of a SATV system
Troubleshoot antenna systems
Repair antenna systems (e.g., replace and align antenna components)

Unit: Industrial Electricity

Competency: Explain basic industrial electricity theory

Competency Builders:

Describe atomic structure and its relationship to electricity
Describe the relationship between electrical and magnetic properties
Describe the electrical and magnetic properties of a magnet
Describe the photoelectric effect
Describe the thermocouple effect
Describe the electrical effect of friction
Identify sources of electricity
Identify potential sources of electricity
Describe differences between AC/DC
Describe effects varying degrees of electricity have on the human body

Competency: Use the National Electrical Code (NEC)

Competency Builders:

Use NEC to identify correct materials
Use NEC to identify correct methods
Use NEC to identify correct applications
Use NEC to identify correct safety procedures

Competency: Explain operation of electrical distribution systems

Competency Builders:

Follow NFPA, local, state, and national codes
Describe functions of permits and licensing requirements
Explain generation of electricity
Explain transmission of electricity
Explain end user distribution

Competency: Maintain basic electrical systems

Competency Builders:

Replace electrical cords
Replace batteries
Replace fuse(s)
Replace switches and other sensors
Replace plugs and sockets
Replace control panel components (e.g., relays, motor starters)
Replace AC motors (e.g., 3 phase, single phase)
Replace DC motors

Competency: Interpret electrical/electronic drawings

Competency Builders:

Interpret basic electric/electronic standards and symbols (e.g., NEC, IEC)
Interpret schematic drawings
Interpret cable drawings
Interpret component drawings
Interpret logic diagrams
Interpret control panel drawings
Interpret connection drawings
Interpret interconnection drawings
Interpret printed circuit board drawings
Interpret harness drawings
Interpret package drawings
Interpret mechanical/electronic production blueprints and assembly drawings

Competency: **Demonstrate proficiency in direct current (DC) circuits**

Competency Builders:

Describe voltage, current, resistance, power, and energy
Solve algebraic problems to include exponential (prerequisite to DC)
Measure properties of a circuit using volt-ohm meter (VOM) and digital volt-ohm meter (DVM) meters and oscilloscopes
Apply Ohm's Law
Construct parallel circuits
Construct series circuits
Construct series parallel and bridge circuits
Define voltage divider circuits (loaded and unloaded)
Construct DC circuits that demonstrate the maximum power transfer theory
Solve problems in electrical units utilizing metric units
Describe the principles and operation of electrochemical supplies
Apply Kirchoff's law
Interpret color codes and symbols to identify electrical components and values
Measure properties of a circuit using analog and digital meters and oscilloscopes
Measure conductance and resistance of conductors and insulators
Describe magnetic properties of circuits and devices
Describe the physical and electrical characteristics of capacitors and inductors
Describe RC and RL time constants
Set up power supplies for DC circuits
Operate power supplies for DC circuits
Analyze frequency spectrums
Apply Thevenin's and Norton's theorems

Competency: **Demonstrate proficiency in alternating current (AC) circuits**

Competency Builders:

Solve basic trigonometric problems as applicable to electricity (prerequisite to AC)
Analyze AC signals utilizing VOM, DVM, oscilloscope, frequency counter and function generator
Analyze power in AC circuits
Measure power in AC circuits
Operate capacitor and inductor analyzers for AC circuits
Analyze properties of an AC signal
Describe the principles and operation of the characteristics of sinusoidal and non-sinusoidal wave forms
Identify AC sources
Describe the principles and operation of the characteristics of capacitive circuits
Demonstrate the operation of capacitive circuits
Describe the principles and operation of the characteristics of inductive circuits
Demonstrate the operation of inductive circuits
Describe the principles and operation of the principles of transformers
Demonstrate the operation of AC circuits utilizing transformers
Operate differentiators and integrators to determine RC and RL time constants
Describe the principles and operation of the characteristics of RLC circuits (series, parallel, and complex)
Demonstrate the operation of RLC circuits (series, parallel, and complex)
Describe the principles and operation of the characteristics of series and parallel resonant circuits
Operate series and parallel resonant circuits
Describe the principles and operation of the characteristics of frequency selective filter circuits
Demonstrate the operation of frequency selective filter circuits
Operate polyphase circuits
Describe basic motor theory and operation
Describe basic generator theory and operation
Operate power supplies for AC circuits
Describe the principles and operation of various power conditioning (e.g., isolation transformers, surge suppressors, uninterruptable power systems)
Describe the principles and operation of various safety grounding systems (e.g., lightning arresters, ground fault interrupters, etc.)
Apply maximum power transfer theorems
Apply Thevenin's and Norton's theorems to analyze AC networks

Unit: Electrical Test and Measurement Equipment

Competency: **Demonstrate proficient use of electrical test equipment**

Competency Builders:

Describe function and operation of logic probe and logic analyzer
Describe function and operation of power monitor
Describe function and operation of signal generator
Describe function and operation of spectrum analyzer
Describe function and operation of AC/DC hi-pot
Describe function and operation of time-domain reflectometer (TDR)
Describe function and operation of megger
Describe function and operation of curve tracer/analogger
Apply test equipment to DC circuits
Apply test equipment to AC circuits
Apply test equipment to solid-state devices
Apply test equipment to digital circuits
Apply test equipment to analog circuits
Apply test equipment to microprocessors

Competency: **Demonstrate proficient use of electrical measurement equipment**

Competency Builders:

Describe function and operation of analog volt-ohm-meter (AVOM)
Describe function and operation of digital volt-ohm-meter (DVOM)
Describe function and operation of amp probe
Describe function and operation of oscilloscopes
Describe function and operation of operation of infrared heat sensor
Apply measurement equipment to DC circuits
Apply measurement equipment to AC circuits
Apply measurement equipment to solid-state devices
Apply measurement equipment to digital circuits
Apply measurement equipment to analog circuits
Apply measurement equipment to microprocessors

Unit: Wiring Methods

Competency: **Apply National Electrical Code (NEC) and National Fire Protection Act (NFPA) Regulations**

Competency Builders:

Use NEC and NFPA to identify correct materials
Use NEC and NFPA to identify correct methods
Use NEC and NFPA to identify correct applications
Use NEC and NFPA to identify correct safety procedures

Competency: **Explain circuit protectors**

Competency Builders:

Explain grounding/bonding methods
Explain ground-fault circuit interrupters
Explain overcurrent/short circuit protection
Explain thermal protective devices

Competency: Install wiring

Competency Builders:

Describe functions of permits and licensing requirements
Interpret prints
Verify on-site dimensions
Install electrical boxes and panels
Describe overhead and underground service
Calculate load size conductors
Identify proper color coding
Lay out conduit runs
Install rigid conduit
Install nonmetallic rigid conduit
Install cable trays
Install flexible conduit
Install liquid-tight flexible conduit
Pull conductors
Install ground bonding systems
Install various wire connectors
Inspect rough installation
Prepare for agency inspection
Install bus-duct(s), bus-plug(s), and bus-drop(s)

Competency: Finish wiring

Competency Builders:

Install plugs and switches
Test plugs and switches
Install fixtures
Test fixtures
Install overcurrent protection
Test overcurrent protection
Install ground-fault interrupters (GFI)
Test ground-fault interrupters (GFI)
Install circuit breakers
Test circuit breakers
Label circuit breakers
Update prints and schematics

Competency: **Prepare for electrical/electromechanical equipment installation**

Competency Builders:

Identify electrical requirements for equipment
Interpret NEC, NFPA, IEC, and state and local electrical codes
Identify a power distribution source/requirements
Interpret symbols
Interpret schematics/drawings
Prepare site

Competency: **Install electrical/electromechanical equipment**

Competency Builders:

Build control panel
Install electrical motor control systems
Install electrical motors
Install sensors and various input devices
Install energy-management systems (e.g., lighting, HVAC, load-shedding)
Test equipment and circuits
Connect power to equipment
Test power to equipment

Competency: **Interpret schematics and diagrams**

Competency Builders:

Identify circuit function
Interpret electrical symbols
Interpret block and ladder diagrams
Interpret schematics

Competency: Trace circuits to locate problems

Competency Builders:

Identify circuit type or subsystem
Locate specific circuits
Apply proper troubleshooting technique(s)

Competency: Maintain electrical systems

Competency Builders:

Diagnose failure
Explain root cause of failure
Review schematic or ladder diagram
Repair or replace defective electrical apparatus
Document corrective action needed or taken

Competency: Use soldering tools

Competency Builders:

Select appropriate soldering tools and supplies for job
Perform soldering and desoldering techniques (e.g., micro-miniature, standard)

Competency: Install Class II systems

Competency Builders:

Define Class II systems
Comply with local, state, and federal codes (e.g., NEC, NFPA)
Install communication system
Install control system
Install lighting system
Install security systems
Install energy management monitoring systems
Maintain systems
Verify system operation

Unit: Drafting Technology

Competency: **Apply basic drafting skills**

Competency Builders:

Use drafting equipment, measuring scales, drawing media, drafting instruments and consumable materials, blueprint machine
Identify line styles, weights (alphabet of lines)
Select proper drawing scale, introduction to different types
Prepare title blocks and other drafting formats
Apply freehand and other lettering techniques
Prepare multi-view drawings
Prepare multi-view sketches
Prepare orthographic views
Prepare change control block
Describe change control block/revision block
Measure angles
Draw horizontal, vertical, angular, parallel, and perpendicular lines
Transfer an angle
Construct tangent lines (to arcs) and tangent arcs (to arcs)
Bisect angles and arcs
Bisect lines
Divide lines
Construct three-point circle
Construct regular hexagon, pentagon, and octagon
Reproduce a drawing
Prepare single-view drawings
Prepare dimension drawings
Interpret notes and dimensions to determine part
Draw arcs, circles, and conics
Transfer measurements

Competency: Apply intermediate drafting skills

Competency Builders:

Describe types of blueprints and their applications
Apply isometric, oblique and perspective sketching techniques
Prepare isometric, oblique and perspective sketches
Prepare sectional views
Prepare auxiliary views
Identify ANSI symbols
Prepare views of drilled and tapped holes, counterbores, countersinks
Apply systems drafting techniques
Identify a bill of materials
Dimension drawings using ANSIy14.5 standards
Describe purpose of auxiliary and sectional views

Competency: Apply advanced drafting skills

Competency Builders:

Interpret reports and specifications
Prepare pictorial drawings
Prepare schematics
Draw conics
Interpret basic pneumatic/hydraulic standard and symbols
Interpret various drawings (e.g., welding, casting, stamping, forging, civil, maps, pattern shop)

Competency: Interpret basic prints

Competency Builders:

Visualize object from drawing
Interpret orthographic projections
Interpret isometric views
Interpret sectional views
Interpret detail and assembly drawings
Interpret dimensions
Interpret tolerances

Competency: Interpret intermediate prints

Competency Builders:

Interpret screw thread specifications
Identify structural steel shapes
Interpret special symbols
Interpret electrical, pneumatic/hydraulic drawings
Interpret schematics

Competency: Interpret advanced prints

Competency Builders:

Interpret GD&T characteristic symbols
Interpret GD&T supplementary symbols

Competency: **Demonstrate knowledge of basic geometric dimensioning and tolerancing**

Competency Builders:

Identify geometric characteristics and symbols (i.e., flatness, straightness, roundness, cylindricity, profile of line, profile of surface, perpendicularly, angularity, parallelism, circular, runout, total indicated runout, position, concentricity, and symmetry)
Define maximum material condition
Define least material condition
Define regardless of feature size condition
Describe feature control blocks
Describe datum surfaces and targets
Define flatness (pitch)
Define straightness (yaw)
Define roundness
Define cylindrically
Define profile of line
Define profile of surface
Define perpendicularity
Define angularity
Define parallelism
Define circular runout
Define total runout
Define true position concept to determine tolerance for location of holes in mating parts

Competency: **Convert dimensions and tolerances**

Competency Builders:

Convert dimensions and tolerances from English units to metric units
Convert dimensions and tolerances from metric units to English units

Competency: Apply revision control process

Competency Builders:

Apply drawing balloons
Apply documentation (including project filing, back-up material, tracking process)
Apply change control block
Apply revision levels

Competency: Demonstrate dimensioning techniques

Competency Builders:

Construct arrowheads using various styles/disciplines
Apply symbols for surface and texture control
Add labels/notes to drawing
Interpret decimal tolerance dimensions
Dimension arcs
Dimension angles
Dimension curves
Dimension rounded-end shapes
Dimension spherical objects
Dimension cylindrical objects
Dimension cones, pyramids, and prisms
Dimension features on circular center line
Dimension theoretical point of intersection
Dimension object using rectangular coordinate system
Dimension object using polar coordinate system
Dimension object using tabular coordinate system
Dimension object using ordinate dimensioning system

Competency: Apply geometric dimensioning and tolerancing

Competency Builders:

Interpret decimal tolerance dimensions
Calculate clearance fit tolerances of mating parts
Dimension clearance fit tolerances of mating parts
Calculate interference fit tolerances of mating parts
Dimension interference fit tolerances of mating parts
Calculate tolerances to mating parts using standard fit tables
Assign tolerances to mating parts using standard fit tables
Apply positional and form tolerancing symbols
Apply symbols for true position
Apply symbols for maximum material control and regardless of feature size
Calculate effects of dimensional stack-up
Calculate transitional fit tolerances
Dimension transitional fit tolerances

Competency: Perform basic physical layouts

Competency Builders:

Use inside diameter (ID), outside diameter (OD), and hermaphrodite calipers
Layout with combination square
Layout with scriber, divider and trammel
Use surface plate
Use surface gage
Use layout fluid
Use V-blocks
Use clamps
Use angle plate
Use parallels
Use punches
Use transfer method tools
Use layout hammer
Use machinist's square
Use universal bevel protractor
Use machinist's scale

Competency: Prepare mechanical drawings

Competency Builders:

Interpret basic mechanical standards and symbols
Prepare assembly drawings
Prepare welding drawings
Prepare bearing drawings
Prepare casting drawings
Prepare forging drawings
Prepare tool drawings
Prepare molding diagrams
Prepare drawings with special processed holes
Prepare stamping drawings
Prepare numerical control drawings/instructions
Prepare installation drawings
Prepare purchase part drawings
Prepare approval drawings

Competency: Prepare advanced mechanical drawings

Competency Builders:

Resolve problems by descriptive geometry and revolutions
Use precision dimensioning to include geometric characters
Use precision measuring instruments (e.g., calipers)
Prepare fastener drawings
Prepare cam drawings
Prepare gear drawings
Prepare spring drawings
Prepare pulley and chain drive drawings

Unit: CADD Fundamentals

Competency: Demonstrate basic use of computer operating system

Competency Builders:

Create ASCII text files with a text editor
Explain rules for naming files and directories
Manage files
Create directories
Remove directories
Change directories
Copy files
Rename files
Erase files
Format diskettes
Label diskettes
Explain the syntax of operating system commands
Use wildcards in operating system commands

Competency: Operate a CADD system

Competency Builders:

Execute CADD system
Use keyboard input
Use screen and tablet menus
Use other input devices (e.g., scanner, digitizer)
Create scaled plots
Operate a pen plotter
Operate a printer-plotter (i.e., laser plotter)
Access on-line help for commands
Use file conversion
Use data transfer

Competency: Select entities for action

Competency Builders:

Add or remove entities separately
Add or remove entities using a window
Add or remove entities with a crossing-box
Select entities using a fence
Select entities by other methods (e.g., last, previous, type, all, etc.)

Competency: Create 2-D orthographic drawings

Competency Builders:

Create primitive drawing entities
Draw utilizing absolute Cartesian coordinates
Draw utilizing relative Cartesian coordinates
Draw utilizing polar coordinates
Draw using construction aides (e.g., snaps, grid, snap, etc.)
Change drawing attributes
Edit drawing entity properties (e.g., color, layer, thickness, linetype)
Construct drawing entities (e.g., offset, timer, extend, break, mirror, etc.)
Edit drawing entities (e.g., offset, trim, extend, break, mirror, etc.)
Set system variables (e.g., units, scale)
Use system variables
Create layers
Name layers
Manipulate layers
Save files
Create back-ups
Create hatches, patterns, symbols
Recall drawing templates/blocks

Competency: Annotate orthographic drawings

Competency Builders:

Create text styles
Edit text styles
Select text styles
Apply notes

Competency: Dimension orthographic drawings

Competency Builders:

Create dimensions
Edit text
Control dimension variables/models

Competency: Control display

Competency Builders:

Apply view control while drawing (e.g., zoom and pan)
Control view resolution (e.g., viewers)
Save views
Display views

Competency: Extract entity and drawing information

Competency Builders:

Measure distances
Measure areas
Identify locations
List entity characteristics (e.g., length, size, location, properties, etc.)

Unit: Equipment Maintenance

Competency: Perform housekeeping

Competency Builders:

Dispose of scrap metal chips, shavings, trash and waste
Clean work area
Store hand tools, cutters, fixtures, jigs and attachments
Store grinding wheels
Follow tool crib procedures
Inspect machine guards
Replace or adjust machine guards
Report problems to supervisor

Competency: Perform recordkeeping

Competency Builders:

Explain reasons for keeping maintenance records
Explain reasons for keeping cost records
Complete work order
Complete internal requisition
Complete external requisition
Complete time cards
Complete job status reports
Complete equipment failure reports
Record preventive maintenance activities
Record repair activities
Read job orders and process sheets
Locate tooling and set up information
File reports
Prepare new/replacement equipment recommendations

Competency: Inspect machine systems

Competency Builders:

Explain planned maintenance
Explain predictive maintenance measures
Explain preventive maintenance measures (e.g., lubrication)
Log machine histories
Explain machine system(s) calibration
Inspect linkages and lever mechanisms
Inspect drive couplings
Inspect clutches
Inspect roller ball bearings
Inspect safety systems
Analyze system failure
Make minor adjustments/repairs
Coordinate maintenance services

Competency: Perform machine maintenance

Competency Builders:

Use operator's and manufacturer's manuals
Operate individual machines
Diagnose malfunctions
Apply lockout/tagout procedure
Disassemble defective section
Clean equipment
Lubricate equipment
Check equipment for wear and alignment
Repair or replace defective parts
Test machine for performance
Make minor adjustments to equipment
Prepare planned maintenance schedules
Explain breakdown maintenance

Competency: Maintain hand tools

Competency Builders:

Demonstrate use and care of measuring devices (e.g., rules, tapes, calipers, micrometers, multimeter, thermometer, and coordinate measuring system)
Demonstrate use and care of equipment used to bend and assemble rigid conduit and tubing
Demonstrate use and care of common hand tools
Demonstrate use and care of wood working tools (e.g., saws, planes, drills, hammers)
Demonstrate use and care of sheet metal tools (e.g., sheet metal gauges, hand seamers, soldering irons)
Demonstrate use and care of ropes, slings, pullers, and block and tackle
Demonstrate proper metal working bench skills (including use of vices, hacksaws, files, tapes, dies, and reamers)
Demonstrate use and care of pipe clearing equipment

Competency: Maintain portable power tools

Competency Builders:

Demonstrate use and care of light-duty and heavy-duty drills
Demonstrate use and care of electric hammers
Demonstrate use and care of pneumatic drills and hammers
Demonstrate use and care of power screwdrivers and impact wrenches
Demonstrate use and care of linear motion saws
Demonstrate use and care of circular saws
Demonstrate use and care of routers and planes
Demonstrate use and care of belt, pad and disc sanders
Demonstrate use and care of grinders and shears
Demonstrate use and care of explosive actuated tools
Demonstrate use and care of electric lifts

Competency: **Maintain stationary equipment**

Competency Builders:

Demonstrate use and care of mechanical presses
Demonstrate use and care of hydraulic presses
Demonstrate use and care of drill presses
Demonstrate use and care of bench grinders
Demonstrate use and care of power saws (e.g., hack, cut-off, chop, band, jig, and table)
Demonstrate use and care of band saws
Demonstrate use and care of pipe threaders
Demonstrate use and care of metal brakes
Demonstrate use and care of power shears

Unit: Electromechanical Technology

Competency: **Interpret electromechanical drawings**

Competency Builders:

Identify types of drawings and their applications
Transfer measurements
Explain the use of auxiliary views, revolutions, and sectional views
Describe dimensioning practices and techniques on drawings
Interpret mechanical/electronic production and assembly drawings

Competency: **Describe the operation of electronic sensors and transducers**

Competency Builders:

Explain temperature transducers operation
Explain stress and strain transducers operation
Explain magnetic transducers operation
Explain liquid and fluid flow transducers operation
Explain fiber optic system operation

Competency: **Demonstrate proficiency in transducers (sensors) and instrumentation**

Competency Builders:

Describe characteristics associated with transducers and instrumentation
Describe the principles and operations of various types of transducers (e.g., thermal, shock/vibration, acceleration, positional, pressure, flow, optical, gas and humidity)
Demonstrate the use of various transducers (e.g., thermal, shock/vibration, acceleration, positional, pressure, flow, optical, gas and humidity)
Troubleshoot transducers
Differentiate among thermocouple types
Interpret specifications of temperature sensors (e.g., thermocouples, thermistors, resistance temperature devices)
Interpret specification of pressure sensors (e.g., strain gage, piezzo electric/piezzo resistive) to electrical circuits
Interpret specifications of flow sensors (e.g., orifice flow meter, turbine meter, mass flow meters)
Interpret specifications of speed or position sensor (e.g., tachometer, resolver encoder, linear voltage differential transformer (LVDT)
Interpret specifications of controllers, indicators, and recorders (e.g., process controllers, programmable logic controllers with interfaces, R-chart recorders, dataloggers/indicators)
Interpret specifications of final control elements (i.e., silicon controlled rectifiers (SCR), power controllers, motor drives, actuators/robots)
Describe application circuits
Calculate specification of proximity sensors
Calculate specifications of infrared and photo-sensors
Explain use of proximity sensors
Explain use of photo electric sensors
Explain use of mechanically activated switches
Troubleshoot switch failure
Describe transducer control and measurement circuits
Demonstrate the use of control and measurement circuits
Troubleshoot control and measurement circuits

Competency: **Demonstrate proficiency in power distribution systems**

Competency Builders:

Describe power distribution systems
Describe poly-phase distribution systems
Describe single-phase distribution systems
Describe DC distribution systems
Describe delta distribution systems
Describe wye distribution systems
Describe medium-voltage distribution systems (less than 600v)
Troubleshoot poly-phase distribution systems
Troubleshoot single-phase distribution systems
Troubleshoot DC distribution systems
Troubleshoot delta distribution systems
Troubleshoot wye distribution systems
Troubleshoot medium-voltage distribution systems

Competency: **Demonstrate proficiency in power distribution equipment**

Competency Builders:

Describe power transformers
Describe power capacitors
Describe power oil switches and cutouts
Describe application of NEMA or IEC controls
Describe different types of enclosures for controls
Describe current transformers
Describe potential transformers
Describe medium-voltage circuits breakers and fuses
Use medium-voltage safety equipment
Troubleshoot power transformers
Troubleshoot power capacitors
Troubleshoot power oil switches and cutouts
Troubleshoot current transformers
Troubleshoot potential transformers
Troubleshoot medium-voltage circuit breakers and fuses

Competency: Demonstrate proficiency in motors and motor control

Competency Builders:

Test solid state components with ohmmeter
Test solid state DC motor control circuits
Test solid state AC motor control circuits
Calibrate or recalibrate equipment
Identify SCR and TRIAC AC control circuits
Explain how load is connected to 3-phase wye configured AC generator
Identify wye connected and delta connected 3-phase motors
Explain revolving fields in AC motors
Describe operation of common AC motors
Describe operation of variable frequency AC drives
Define advantages and disadvantages of common DC motors
Explain how motor load affects speed regulation
Describe operation of stepper motors
Describe speed control of various types of motor drives using sensors
Identify defective motors
Describe regenerative dynamic breaking
Describe operation of various feedback loops

Competency: Apply quality control techniques

Competency Builders:

Perform preventive maintenance
Perform predictive maintenance
Apply statistical process control (SPC)
Recalibrate equipment
Apply problem-solving tools and techniques

Competency: **Apply electromechanical maintenance management practices**

Competency Builders:

Keep maintenance records
Complete work order
Complete internal requisition
Complete external requisition
Explain planned maintenance
Explain breakdown maintenance
Explain predictive maintenance
Establish maintenance schedules
Explain reasons for keeping maintenance records
Explain reasons for keeping cost records
Analyze system failure
Make minor adjustments/repairs
Coordinate maintenance service
Make new/replacement equipment recommendations
Interpret bill of materials for allocation, stocking, and raw material information
Analyze use of bill of materials for workplace decision making

Unit: Fundamentals of Machine Anatomy

Competency: Interpret specifications for a machine

Competency Builders:

Identify power source
Identify power transmission
Identify hydraulic/pneumatic actuators
Identify materials
Identify fits/tolerances
Identify GD&T symbols
Identify safety factors
Participate in concurrent engineering
Demonstrate knowledge of print reading

Competency: Build a machine to specifications

Competency Builders:

Install hydraulic and pneumatic actuators
Troubleshoot hydraulic and pneumatic actuators
Install motors
Troubleshoot motors
Install sensors
Troubleshoot sensors
Install PLC's
Troubleshoot PLC's
Install industrial controls
Troubleshoot industrial controls
Install power distribution systems
Troubleshoot power distribution systems
Install brakes and clutches
Troubleshoot brakes and clutches
Install lubrication system
Troubleshoot lubrication system

Unit: Hydraulics and Pneumatics

Competency: Describe fluid flow concepts

Competency Builders:

Explain Pascal's Law
Explain Boyle's Law
Explain Bernoulli's Principle
Describe flow velocity
Explain how heat and pressure relate to power and transmission
Describe physical and chemical properties of a fluid
Describe fluids in motion in closed conductors
Describe continuity of mass flow
Identify types of fluids
Identify properties of fluids
Identify English and metric units of measurement for pressure, density, and viscosity

Competency: Describe energy considerations

Competency Builders:

Differentiate work and power
Differentiate potential and kinetic energy
Explain energy conservation concept
Explain hydraulic horsepower
Explain work of compression in compressible fluids

Competency: Describe system losses

Competency Builders:

Differentiate turbulent and laminar flow
Explain friction factor
Explain pressure losses
Identify potential system losses (e.g., leaks, wear, component sizing, heat, dirt)

Competency: Describe hydrostatics

Competency Builders:

Explain pressure, density, and viscosity
Explain buoyancy
Explain equilibrium

Competency: Calculate energy

Competency Builders:

Apply Pascal's Law
Apply Bernoulli's Principle
Apply Boyle's Law
Calculate work and power
Calculate potential and kinetic energy
Calculate hydraulic horsepower
Calculate flow velocity and pressure
Calculate pressure losses
Calculate laminar flow
Calculate pump capacity
Calculate system requirements

Competency: Design basic hydraulic/pneumatic system

Competency Builders:

Use common symbols
Create circuit diagrams (i.e., schematics)
Diagram closed-loop hydraulic system
Diagram an air supply system

Competency: Describe component operation

Competency Builders:

Identify functions and operation of hydraulic components
Identify functions and operation of pneumatic components
Explain application(s) of different materials (e.g., plastic, copper)

Competency: **Interpret hydraulic and pneumatic schematics**

Competency Builders:

Identify common symbols
Sketch circuit diagrams (i.e., schematics)
Interpret circuit diagrams (i.e. schematics)
Sketch circuit analysis
Diagram an air supply system

Competency: **Troubleshoot hydraulic and pneumatic circuits**

Competency Builders:

Analyze hydraulic circuits
Troubleshoot hydraulic circuits
Analyze pneumatic circuits
Troubleshoot pneumatic circuits

Competency: **Perform pump maintenance and repair**

Competency Builders:

Identify types and operating features of pumps
Identify pump capacity and system requirements
Explain packing and seal requirements
Explain operating principles of pumps (e.g., centrifugal, propeller and turbine rotary, metering)
Perform pump maintenance
Disassemble a pump
Reassemble a pump

Competency: **Maintain piping and accessories for high and low pressure fluid power systems**

Competency Builders:

Identify components of a piping system
Explain maintenance features of both metallic and non-metallic piping systems
Explain types of values and their operation and maintenance
Explain use and maintenance of strainers, filters, and traps in piping systems
Join common fittings
Join metallic pipe
Join plastic pipe
Join copper and steel tubing
Bend copper and steel tubing
Cut copper and steel tubing
Flare tubing

Competency: **Maintain hydraulic system components**

Competency Builders:

Install a contaminant removal system
Maintain a contaminant removal system
Explain operation and use of heat exchanges
Identify reservoir requirements
Compute hose requirements
Install hydraulic lines
Select control valves and servo-type valves
Install control valves and servo-type valves

Competency: Troubleshoot hydraulic systems

Competency Builders:

Interpret hydraulic schematic
Identify causes of failure modes
Connect electrically controlled valves
Explain hydraulic system troubleshooting techniques
Repair or replace hydraulic valves
Repair or replace hydraulic cylinders
Repair or replace hydraulic pumps and motors
Install hydraulic components

Competency: Describe reciprocating and rotary air compressors

Competency Builders:

Explain relationship of force, weight, mass, and density in pneumatic system
Explain operation of reciprocating compressors
Explain operation of rotary compressors
Explain primary and secondary air treatment (e.g., air dryers, lubricating systems)
Explain operation of compressor valves, cylinders, and motors

Competency: Maintain pneumatic systems

Competency Builders:

Install pneumatic system components
Explain pneumatic system maintenance techniques
Explain pneumatic system troubleshooting procedures
Isolate faults in air compressors
Repair or replace air compressors
Isolate faults in control valves
Repair or replace control valves
Isolate faults in air motors
Repair or replace air motors
Isolate faults in air dryers
Repair or replace air dryers
Maintain proportioning and servo valves

Competency: Troubleshoot pneumatic systems

Competency Builders:

Interpret pneumatic schematic
Diagram an air supply system
Install pneumatic system components
Explain pneumatic system troubleshooting procedures
Troubleshoot air compressors
Troubleshoot pneumatic control valves
Troubleshoot air motors
Troubleshoot air dryers

Competency: **Maintain vacuum systems**

Competency Builders:

Describe characteristics associated with vacuum systems and sub atmospheric pressure
Describe the principles and operation of vacuum gauges
Demonstrate use of vacuum gauges
Repair or replace vacuum gauges
Describe the principles and operation of vacuum pumps
Demonstrate use of vacuum pumps
Repair or replace vacuum pumps
Describe the principles and operation of vacuum controls
Demonstrate use of vacuum controls
Repair or replace vacuum controls

Unit: Industrial Manufacturing Technology

Competency: Describe industrial manufacturing process

Competency Builders:

Demonstrate use and maintenance of personal protective equipment
Explain techniques of measuring motion, forces, voltage, current, power, distance, time and temperature
Explain mechanical and chemical properties of ferrous and non-ferrous metals
Explain industrial manufacturing process
Explain industrial use of non-metallic solids (e.g., ceramics, polymers), liquids, and gases
Develop flow chart and process sheets
Draft preventive maintenance and calibration procedures
Explain need for manufacturing documentation (e.g., ISO 9000)
Define quality process

Competency: Demonstrate knowledge of materials requirements planning

Competency Builders:

Define materials requirements planning
Explain importance of maintaining and controlling inventory (e.g., quantity, price, quality, minimal lot sizes, and timeliness)
Define master production schedule and bill of materials
Explain inventory carrying cost and economic order quantity
Describe the use of the computer in MRP
Calculate net requirements

Competency: **Demonstrate knowledge of supply materials**

Competency Builders:

Describe role of purchase requisitions
Describe role of material specifications
Describe role of quality parameters
Define supplier certification rating methods
Describe role of source inspector
Describe role of receiving

Competency: **Demonstrate knowledge of plant layouts**

Competency Builders:

Describe the importance of flexibility
Differentiate among product layout, process layout, fixed position layout, and cellular layout
Describe the type of production suited to each layout
Describe advantages and disadvantages of each layout

Competency: **Demonstrate knowledge of material flow**

Competency Builders:

Describe importance of flexibility
Differentiate straight-line, U-shaped, S-shaped, convoluted and comb patterns
Describe advantages and disadvantages of each pattern

Competency: Maintain quality control of materials handling

Competency Builders:

Maintain system for physical handling and movement of material in-process and in-storage
Monitor system of physical handling and movement of material in-process and in-storage
Maintain system for physical handling and movement of finished products
Monitor system of physical handling and movement of finished products
Write requests for deviation from specifications
Implement quality control and inspection standards and procedures
Write engineering change notices and rejection reports
Monitor reports of discrepancy or rejects during production process
Conduct quality tests under different environmental conditions

Competency: Demonstrate knowledge of post-production control

Competency Builders:

Explain importance of product protection, identification and storage
Describe methods of identifying products (e.g., labels, bar codes, radio frequency systems and magnetic strip systems)
Describe manual methods of storage and retrieval
Describe automated storage and retrieval systems (ASRS)
Describe automated guided vehicle moving systems (AGVS)

Competency: Analyze a manufacturing project

Competency Builders:

Explain the "how" of project selection
Explain the "how" of project implementation
Explain the "how" of project evaluation
Explain the "how" of planning continuing improvement
Explain the "how" of planning predictive maintenance

Unit: Programmable Logic Controllers (PLCs)

Competency: Differentiate among process controls

Competency Builders:

Describe characteristics associated with automatic controls
Define proportional control
Define integral control
Define derivative control
Describe advantages of using proportional, integral or derivative control
Describe disadvantages of using proportional, integral or derivative control

Competency: Explain basic operation of PLCs

Competency Builders:

Describe basic applications of PLCs
Identify program symbols and language functions
Describe function of block transfers
Describe operation of timers, counters, and sequences
Describe operation of analog I/O modules
Describe operation of servo motion control
Describe the principles and operation of PLCs

Competency: Demonstrate use of PLCs

Competency Builders:

Draw block diagram of a PLC
Define individual blocks of a PLC
Use operator's and/or manufacturer's manual(s)
Translate relay logic to logic for a PLC
Use function of block transfers
Operate timers, counters and sequencers
Operate analog I/O modules
Operate servo motion control
Install a PLC
Connect controller to sensors
Describe test procedures for new installation of a PLC
Troubleshoot hardware faults on a PLCs
Use safety interlock
Describe use of (Graphic Programmable Panel) GPP
Write a statement and ladder logic program
Document a statement and ladder logic program
Use a PLC program
Troubleshoot a program for a PLC
Repair a program for a PLC

Competency: **Apply robot fundamentals**

Competency Builders:

Describe the operation of robotic work cells
Operate robotic work cells
Troubleshoot robotic work cells
Repair robotic work cells
Classify robots according to industry criteria
Identify robot power drive types
Describe positioning in terms of axis, actuators and coordinate system
Identify types of control systems and sensors
Apply different methods of programming (e.g., teach, off-line)
Write simple programs to exercise robot functions
Join programs to perform full function
Identify principles of robot safety
Describe operation of various sensors used in robot control
Interface sensors to robot
Interface robots
Define open loop and closed loop control
Design a simple automated system to perform manufacturing operation
Identify operation of end-effectors

Unit: Computerized Numerical Control (CNC)

Competency: Demonstrate knowledge of CNC

Competency Builders:

Define numerical control (NC) and computerized numerical control (CNC)
Differentiate NC and CNC
Describe closed loop, open loop, and adaptive controls
Define point to point systems
Identify tool movement of point to point systems
Define continuous path systems
Identify tool movements of continuous path systems
Identify data input mediums
Explain the purpose of the post-processor
Define canned cycles
Identify computer memory types
Identify information stored relative to computer memory types
Differentiate hardware and software
Differentiate among CNC, machining centers, and robots
List advantages/disadvantages of CNC machining centers
Explain direct numerical control (DNC)

Competency: Perform preventive maintenance

Competency Builders:

Follow proper safety procedures
Clean CNC equipment
Lubricate CNC equipment
Check CNC equipment for wear and alignment

Competency: Apply CNC operations

Competency Builders:

Identify parts of the machine
Apply basic programming skills to a turning and a milling operation
Select proper work holders
Select proper cutting tools
Set machine parts to drawing tolerances
Use CAD/CAM for part program development

Competency: Prepare CNC program

Competency Builders:

Write a program manually in word address format
Write a program off line
Write a program manually in conversational program
Generate a program using CAD/CAM package
Program machine using manual data input (MDI) process

Competency: Program CNC operations

Competency Builders:

Apply ANSI drawing standards
Apply process planning from drawing to finished product
Analyze workpiece
Contrast differences in computer-assisted programming
Perform basic trigonometric computations
Perform special perception mathematical computations
Set chip load, feed rates and surface feet per minute limitations
Turn intersection points into segments (i.e., defined in terms of points, lines, and circles)
Debug program

Competency: Load machine

Competency Builders:

Load program from MDI and off-line programming station
Prepare work-holding device
Mount work-holding device
Secure workpiece
Set up reference and clearance points
Set up tooling
Select proper lubrication/coolant

Competency: Operate CNC machine

Competency Builders:

Load raw material
Start cycle
Monitor work in-process
Edit CNC programs
Demonstrate ability to halt running program
Apply proper safety procedures
Demonstrate proper cleaning of CNC machine

Competency: Manufacture workpiece (e.g., rectangular, round, angular)

Competency Builders:

Dry-run machine
Run part
Inspect part

TECH PREP

"GET SERIOUS . . . ABOUT SUCCESS"

Instrumentation Control Technician

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—NOTICE—

Each Tech-Prep Competency Profile developed should respond to the labor market demands of your Tech Prep Consortium. Therefore, the following pages should be examined carefully before being selected for use in TCP Part I. **[See "The TCP Process" for more information.]** For example, in some cases the number of units far exceeds the amount of content that can be covered within a 4 + 2 TPAD Program. All the units listed in this section will not necessarily apply to your situation, nor will all the competencies within each unit be appropriate. Note that several units appear within each specific occupation and would need to only appear once if you are compiling a cluster of occupations. **[See "TCP Matrix" and "How to Use the TCP Binder" for more information.]**

Unit: Communications Literacy

NOTE: This content was extracted from the 9-12 cluster of Ohio's Model Language Arts Program. Due to statewide initiatives other than Tech Prep, this literacy unit was not altered to meet competency-based criteria. Each literacy unit forms a critical link between academic teachers and members of business, industry, and labor. [See "The TCP Process" for more information.]

Subunit: Reading—Structure

Competencies:

RS1	Exhibit knowledge of language structure
RS2	Recognize that there may be more than one interpretation of reading selections
RS3	Recognize various literary devices
RS4	Recognize and discuss literary elements
RS5	Develop and use an increasingly sophisticated vocabulary gained through context
RS6	Apply knowledge of language structure to reading
RS7	Explain why there may be more than one interpretation of reading selections
RS8	Recognize effect of literacy devices on meaning
RS9	Analyze author's use of literary elements
RS10	Recognize relationship of structure to meaning
RS11	Describe various interpretations and meaning levels in reading selections
RS12	Characterize author's use of literary devices
RS13	Characterize use of literary techniques
RS14	Critique a variety of literature with regard to plot, dialogue, theme, setting, and characterization
RS15	Apply an expanding vocabulary gained through reading
RS16	Explain various interpretations and meaning levels in reading selections
RS17	Analyze use of literary techniques (e.g., extended metaphor, simile, personification, hyperbole, pun, alliteration)
RS18	Understand use of literary devices (e.g., irony, satire, allegory, onomatopoeia)
RS19	Analyze and synthesize pieces of literature with regard to plot, dialogue, theme, setting, and characterization

Subunit: Reading—Meaning Construction
Competencies:

RM1	Demonstrate ability to recognize appropriate pre-reading strategies
RM2	Describe effectiveness of a reading selection
RM3	Read to clarify personal thinking and knowledge
RM4	Support interpretation of text by locating and citing specific information
RM5	Develop personal response to a variety of literary works
RM6	Recognize diverse literary interpretations
RM7	Engage in self-selected reading activities
RM8	Confirm and extend meaning in reading by researching new concepts and facts
RM9	Self-monitor and apply corrective strategies when communication has been interrupted or lost
RM10	Use features of literary genres to extend meaning
RM11	Assess effectiveness of a selection read
RM12	Use reading as a possible problem-solving strategy to clarify personal thinking and knowledge
RM13	Use knowledge of semantic elements (e.g., figurative language, denotation, connotation, dialect) to clarify meaning when reading
RM14	Predict, recognize, interpret, and analyze themes based on familiarity with author's work
RM15	Compare and contrast literary genres
RM16	Assess validity and quality of selection read
RM17	Clarify meaning when reading
RM18	Compare personal reaction to critical assessment of a literary selection
RM19	Assess validity of diverse literary interpretations
RM20	Use reference books to find, evaluate, and synthesize information
RM21	Identify tone of a literary work
RM22	Critique validity of diverse literary interpretations
RM23	Integrate personal reaction to and critical assessment of a literary selection

Subunit: Reading—Application
Competencies:

RA1	Select and read material for personal enjoyment and information
RA2	Read a variety of complete, unabridged works
RA3	Employ various reading strategies according to purpose
RA4	Participate in selection of books, materials, and topics for literature study groups
RA5	Develop and apply knowledge of the interrelationship of concepts
RA6	Read selections from a variety of styles and formats, recognizing that style and format influence meaning
RA7	Extend value of reading, writing, speaking, viewing, and listening by pursuing, through reading, new concepts and interests developed as a result of these activities
RA8	Read extensively from a particular author's work and explain elements
of	author's style

Subunit: Reading—Multidisciplinary
Competencies:

RM1	Connect themes and ideas across disciplines through literature
RM2	Read to facilitate learning across curriculum
RM3	Read to develop awareness of human rights and freedom
RM4	Participate actively in a community of learners
RM5	Recognize and explain interaction between literature and various cultural domains (e.g., social technological, political, economic)
RM6	Explore and analyze a variety of cultural elements, attitudes, beliefs, and value structures by men and women of many racial, ethnic, and cultural groups
RM7	Value thinking and language of others
RM8	Relate literature to historical period about which or in which it was written
RM9	Read to facilitate content learning

Subunit: Writing—Structure
Competencies:

WS1	Develop and expand a repertoire of organizational strategies (e.g., narration, comparison/contrast, and description) through a practice and discussion
WS2	Clarify word choice according to audience, topic, and purpose
WS3	Locate and correct errors in usage, spelling, and mechanics using a variety of resources
WS4	Recognize information gained from primary and secondary sources
WS5	Develop writing which contains ordered, related, well-developed paragraphs with sentences of varied lengths and patterns
WS6	Use information from a variety of sources to develop an integrated piece of writing
WS7	Evaluate and revise writing to focus on such things as audience, tone, and purpose
WS8	Recognize differences between documentation and reference list styles
WS9	Develop extended pieces of writing which contain ordered, related, well-developed paragraphs with sentences of varied lengths and patterns
WS10	Select from a repertoire of organization strategies a pattern appropriate to a topic
WS11	Synthesize information from a variety of sources
WS12	Refine word choice and tone according to audience, situation, and purpose
WS13	Appropriately cite information gained from primary and secondary sources
WS14	Use style manuals or software to prepare documentation and reference lists
WS15	Develop effectively organized pieces of expository writing containing strong voice, clear thesis, and well-developed ideas
WS16	Identify organization patterns appropriate to writing topic
WS17	Respond to others' suggested revisions to a writing piece

Subunit: Writing—Meaning Construction

Competencies:

WM1	Demonstrate knowledge of the recursive nature of the writing process by applying it appropriately to various topics, situations, and audiences
WM2	Develop criteria for writing evaluation using scoring guides and peer/teacher assistance to clarify meaning
WM3	Respond to others' suggested revisions to a piece of writing
WM4	Use word processing, graphics, and publishing aids to construct meaning in writing
WM5	Engage in self-initiated writing activities
WM6	Incorporate personal criteria with generally accepted standards for writing evaluation
WM7	Evaluate, analyze, and synthesize information for writing
WM8	Evaluate own writing using personal and established scoring criteria
WM9	Assess personal/peer revisions to a writing piece
WM10	Recognize and refine personal writing styles

Subunit: Writing—Application
Competencies:

WA1 Apply appropriate writing techniques suitable for varied writing tasks
WA2 Use sentence-combining techniques to improve syntactic fluency and maturity
WA3 Write in response to prompted and self-selected topics in practical, persuasive, descriptive, narrative, and expository domains
WA4 Develop personal voice in writing
WA5 Consider audience and purpose for writing
WA6 Develop criteria for selection and potential development of topic
WA7 Write in a journal or learning log to clarify personal thinking and knowledge
WA8 Apply an expanding vocabulary gained through writing
WA9 Make judicious use of reference sources (e.g., dictionary, thesaurus, on-lien data base, encyclopedia)
WA10 Demonstrate, an appreciation for aesthetically pleasing language through word choice and style
WA11 Apply revising and editing strategies needed for writing task
WA12 Vary sentence lengths and patterns
WA13 Refine personal voice in writing
WA14 Vary styles and formats for intended purpose and audience
WA15 Apply criteria for selection and development of topic
WA16 Participate in peer review of writing in progress
WA17 Use transitions between sentences, ideas, and paragraphs in writing
WA18 Revise and edit papers extensively in preparation for presentation/publication
WA19 Develop a variety of genres
WA20 Focus writing and tone on such elements as audience, situation, and purpose
WA21 Develop topic fully and appropriately
WA22 Use writing process to clarify personal thinking and knowledge
WA23 Apply appropriate recursive writing process as suggested by writing task and writer's process
WA24 Develop an extended piece of writing
WA25 Revise writing and tone to assure focus on such elements as audience, situation, and purpose
WA26 Use writing process to write reflectively

Subunit: Writing—Multidisciplinary

Competencies:

WM1	Use writing process for learning across curriculum
WM2	Use writing process to demonstrate knowledge of need for human rights and freedom
WM3	Value and apply collaborative skills in writing process
WM4	Write in response to reading, speaking, viewing, and listening
WM5	Use multidisciplinary resources in writing projects
WM6	Use writing process to facilitate learning across curriculum
WM7	Recognize value of and engage in collaboration in writing process
WM8	Use communication processes to develop a published writing piece in collaboration with others
WM9	Record experiences and observations related to content learning
WM10	Apply collaborative skills in writing process
WM11	Write collaboratively with peers
WM12	Use cross-disciplinary resources in writing projects

Subunit: Listening/Visual Literacy—Structure

Competencies:

LS1	Listen to and view a wide variety of genres
LS2	Become aware of an author's style through listening and viewing a variety of works
LS3	Recognize correct and appropriate grammar, diction, and syntax
LS4	Expand vocabulary through listening to and viewing varied media
LS5	Recognize beauty of language
LS6	Enhance recognition of an author's style through listening and viewing a variety of works
LS7	Recognize use and misuse of language in media
LS8	Refine knowledge of style through listening and viewing multiple works by the same author
LS9	Expand and refine grammar, diction, and syntax through listening
LS10	Compare authors' styles through viewing and listening to their works
LS11	Expand knowledge of complex grammar, diction, and syntax issues

Subunit: Listening/Visual Literacy—Meaning Construction
Competencies:

LM1	Develop critical thinking skills necessary to evaluate media and assess oral presentations
LM2	Compare new oral texts to past experiences and knowledge in order to enhance comprehension
LM3	Recognize how rhythmic patterns, silence, and cadences enhance quality of speech and literature
LM4	Focus listening and viewing on themes and/or plots
LM5	Gather information from listening and viewing experiences to enhance research
LM6	Use critical thinking skills to evaluate media and oral presentations
LM7	Use prior knowledge and experiences to facilitate comprehension of new oral texts
LM8	Identify rhythmic and time patterns in speech and literature
LM9	Identify and analyze themes and/or plots when listening and viewing
LM10	Use information gathered from listening and viewing experiences to expand research
LM11	Enhance use of critical thinking skills to evaluate media and oral presentations
LM12	Consider prior knowledge and experiences when attempting to understand the meaning of new texts
LM13	Appreciate rhythmic and time patterns of speech and literature
LM14	Select viewing and listening materials to support written text
LM15	Evaluate media and oral presentations analytically and critically
LM16	Organize prior knowledge and experiences to comprehend new texts
LM17	Organize and use viewing and listening materials to support written text

Subunit: Listening/Visual Literacy—Application
Competencies:

LA1	Listen attentively during oral reading
LA2	Use media as stimuli for learning and thinking
LA3	Develop knowledge of structure through art, music, and literature
LA4	Use electronic media to enhance and highlight language learning
LA5	Listen and view for entertainment and enjoyment
LA6	Use technology and other media as means of expressing ideas

Subunit: Listening/Visual Literacy—Multidisciplinary

Competencies:

LM1	Facilitate learning across curriculum through critical listening and viewing
LM2	Engage in individual, small-group, and whole-group listening and viewing activities
LM3	Develop language arts (e.g., viewing, listening) projects collaboratively
LM4	Investigate language and cultural differences through listening and viewing activities
LM5	Participate in a community of learners through productive listening

Subunit: Oral Communication—Structure

Competencies:

OS1	Refine oral communication skills
OS2	Demonstrate knowledge of grammar, usage, and syntax when presenting
OS3	Select topics and vocabulary suitable to audience
OS4	Organize notes and ideas for speaking
OS5	Use language imaginatively
OS6	Modulate voice to meaning when interpreting literature orally
OS7	Organize notes and ideas for formal, semiformal and informal presentations of information
OS8	Refine speaking techniques for formal, semiformal, and informal settings
OS9	Develop repertoire of organizational strategies for presenting information orally
OS10	Expand vocabulary to fit topic
OS11	Select topics suitable to audience, situation, and purpose
OS12	Select appropriate strategies when organizing notes and ideas for speaking

Subunit: Oral Communications—Meaning Construction

Competencies:

OM1	Make connections between prior knowledge and new information for oral presentations
OM2	Participate in informal speaking activities
OM3	Use interviewing techniques to gather information
OM4	Communicate orally to entertain and to inform
OM5	Participate in group communication activities
OM6	Take and organize notes when preparing speech/presentation
OM7	Interpret texts orally to illustrate meaning
OM8	Respond to needs of various audiences
OM9	Gather and assess information for speaking
OM10	Communicate orally to inform and persuade
OM11	Prepare and deliver formal speech/presentation
OM12	Participate in a variety of oral interpretations
OM13	Assess needs of audience and adjust language and presentation according to their knowledge
OM14	Analyze and synthesize information for speaking
OM15	Describe effectiveness of literary selection
OM16	Describe topic or idea in order to clarify personal/audience thinking
OM17	Analyze and synthesize information gathered from a variety of sources for speaking
OM18	Describe validity and/or quality of a literary selection and justify selection
OM19	Interpret orally a variety of literature
OM20	Describe topic or idea to clarify meaning for others

Subunit: Oral Communication—Application

Competencies:

OA1	Become proficient at using interviewing techniques
OA2	Give an oral interpretation for a specific audience
OA3	Develop and apply oral communication skills for cooperative/collaborative learning
OA4	Use oral communication for a variety of purposes and audiences (e.g., negotiations, book reviews, rationales)
OA5	Develop and apply decision-making strategies
OA6	Practice interviewing techniques
OA7	Apply interviewing techniques to purposeful interviews
OA8	Focus oral interpretation on a specific audience

Subunit: Oral Communications—Multidisciplinary

Competencies:

OM1	Value thinking and language of others
OM2	Develop oral projects collaboratively
OM3	Be involved in individual, small-group, and whole-group language activities
OM4	Participate actively in a community of learners
OM5	Investigate language and cultural differences through oral language activities

Unit: Mathematics Literacy

NOTE: This content was extracted from the 9-12 cluster of Ohio's Model Mathematics Program. Due to statewide initiatives other than Tech Prep, this literacy unit was not altered to meet competency-based criteria. Each literacy unit forms a critical link between academic teachers and members of business, industry, and labor. [See "The TCP Process" for more information.]

Subunit: Numbers and Number Relations

Competencies:

NR1	Compare, order, and determine equivalence of real numbers
NR2	Estimate answers, compute, and solve problems involving real numbers
NR3	Compare and contrast real number system, rational number system, and whole number system
NR4	Extend knowledge to complex number system and develop facility with its operation

Subunit: Measurement

Competencies:

M1	Estimate and use measurements
M2	Understand need for measurement and probability that any measurement is accurate to some designated specification
M3	Understand and apply measurements related to power and work
M4	Understand and apply measurement concepts of distance-rate-time problems and acceleration problems
M5	Use real experiments to investigate elasticity, heat, sound, electricity, magnetism, light, acceleration, velocity, energy, and gravity
M6	Use real-world problem situations involving mass and weight
M7	Use real-world problem situations involving simple harmonic motion
M8	Establish ratios with and without common units
M9	Construct and interpret maps, tables, charts, and graphs as they relate to real-world mathematics
M10	Understand and solve rate-change problems
M11	Understand and solve right triangle relationships as they relate to measurement, specifically to Pythagorean theorem
M12	Graph and interpret ordered pairs
M13	Compute total sales from a variety of items
M14	Comprehend and compute rates of growth or decay
M15	Comprehend, compute, and interpret real problems involving annuities

Subunit: Measurement (continued)

Competencies:

M16	Develop an ability to identify real problems and provide possible solutions
M17	Express and apply different types of measurement scales
M18	Identify area and volume

Subunit: Estimation and Mental Computation

Competencies:

E1	Use estimation to eliminate choices in multiple-choice tests
E2	Use estimation to determine reasonableness of problem situations in a wide variety of applications
E3	Estimate shape of graphs of various functions and algebraic expressions
E4	Use mental computation when computer and calculator are inappropriate

Subunit: Data Analysis and Probability

Competencies:

D1	Organize data into tables, charts, and graphs
D2	Understand and apply measures of central tendency, variability, and correlation
D3	Use curve fitting to predict from data
D4	Use experimental or theoretical probability, as appropriate, to represent and solve problems involving uncertainty
D5	Use computer simulations and random number generators to estimate probabilities
D6	Test hypotheses using appropriate statistics
D7	Read, interpret, and use tables, charts, and graphs to identify patterns, note trends, draw conclusions, and make predictions
D8	Identify probabilities of events involving unbiased objects
D9	Use sampling and recognize its role in statistical claims
D10	Design a statistical experiment to study problem, conduct experiment, and interpret and communicate outcomes
D11	Describe normal curve in general terms and use its properties
D12	Create and interpret discrete probability distributions
D13	Understand concept of random variable
D14	Apply concept of random variable to generate and interpret probability distributions, including binomial, uniform, and chi square

Subunit: Algebra
Competencies:

A1 Describe problem situations by using and relating numerical, symbolic, and graphical representations
A2 Use language and notation of functions in symbolic and graphing settings
A3 Recognize and use equivalent zeros of a function, roots and the solution of an equation in terms of graphical and symbolic representations
A4 Describe and use logic of equivalence in working with equations, inequalities, and functions
A5 Develop graphical techniques of solution for problem situations involving functions
A6 Explore and describe characterizing features of functions
A7 Make arguments and proofs in algebraic settings
A8 Factor difference of two squares
A9 Identify slope, midpoint, and distance
A10 Explore and combine rational functions
A11 Explore factoring techniques
A12 Solve quadratic equations by factoring and formula
A13 Set up and solve linear equations
A14 Solve systems of linear equations with two variables
A15 Describe geometric situations and phenomena using variables, equations, and functions
A16 Describe measures of central tendency, mean, median, mode, and variance algebraically and graphically
A17 Represent inequalities on number line and in coordinate plane
A18 Use coordinate arguments in making geometric proofs
A19 Symbolize transformations of figures and graphs
A20 Explore geometric basis for functions of trigonometry
A21 Graph linear functions
A22 Develop and use vectors to represent direction and magnitude including operations
A23 Use polar and parametric equations to describe, graph, and solve problem situations
A24 Represent sequences and series as functions both algebraically and graphically
A25 Explore recursive functions and procedures using spreadsheets, other computer utilities, and appropriate notions
A26 Describe and solve algebraic situations with matrices
A27 Describe and use inverse relationship between functions including exponential and logarithmic

Subunit: Algebra (continued)
Competencies:

A28 Analyze and describe errors and error sources that can be made when using computers and calculators to solve problems

A29 Decide whether problem situation is best solved using computer, calculator, paper and pencil, or mental arithmetic/estimation techniques

A30 Explore relationships between complex numbers and vectors

A31 Make arguments concerning limits, convergence and divergence in context involving sequences, series, and other types of functions

A32 Represent transformations in plane with matrices

A33 Contrast and compare algebra's of rational, real, and complex numbers with characteristics of a matrix algebra system

A34 Construct polynomial approximations of a function over specified intervals of convergence

A35 Examine complex numbers as zeros of functions

A36 Translate verbal statements into symbolic language

A37 Simplify algebraic expressions

A38 Use laws and exponents (including scientific notation)

A39 Expand and extend idea of vectors and linear algebra to higher dimensional situations

A40 Use the idea of independent basis elements for a vector space and associated fundamental concepts of finite dimensional linear algebra

A41 Develop and communicate arguments about limit situations

A42 Use matrices to describe and apply transformations

A43 Develop and use polar and parametric equations to represent problem situations

A44 Explore proofs by mathematical induction

Subunit: Geometry
Competencies:

G1	Create and interpret drawings of three-dimensional objects
G2	Represent problem situations with geometric models and apply properties of figures
G3	Apply Pythagorean theorem
G4	Demonstrate knowledge of angles and parallel and perpendicular lines
G5	Explore inductive and deductive reasoning through applications to various subject areas
G6	Translate between synthetic and coordinate representations
G7	Identify congruent and similar figures using transformation with computer programs
G8	Deduce properties of figures using transformations and coordinates
G9	Use deductive reasoning
G10	Explore compass and straightedge constructions in context of geometric theorems
G11	Demonstrate knowledge of and ability to use proof
G12	Use variety of proof techniques (e.g., synthetic, transformational, and coordinate)
G13	Use variety of proof formats, including T-proof (i.e., two-column) and paragraph proof
G14	Explore different proof strategies
G15	Investigate different proofs of theorems
G16	Develop knowledge of an axiomatic system
G17	Apply transformations and coordinates in problem solving
G18	Represent problem situations with geometric models and apply properties of figures
G19	Deduce properties of figures using vectors
G20	Analyze properties of Euclidean transformations and relate translations to vectors
G21	Apply vectors in problem solving
G22	Develop further knowledge of axiomatic systems by investigating and comparing various geometry's

Subunit: Patterns, Relations, and Functions
Competencies:

P1 Model real-world phenomena with polynomial and exponential functions
P2 Explore relationship between zeros and intercepts of functions
P3 Translate among tables, algebraic expressions, and graphs of functions
P4 Use graphing calculator or computer to generate graph of a function
P5 Explore relationship between a linear function and its inverse
P6 Describe and use characteristics of polynomial functions in problem-solving situations
P7 Explore conic sections and graph using graphing calculator or computer
P8 Apply trigonometric functions to problem situations involving triangles
P9 Discover relationships between algebraic description, kind, and properties of conic
P10 Explore periodic real-world phenomena using sine and cosine functions
P11 Analyze effects of parameter changes on graphs
P12 Use graphing calculator or computer to graph functions
P13 Develop an knowledge of rational and transcendental functions
P14 Understand connections between trigonometric and circular functions
P15 Use circular functions to model periodic real-world functions
P16 Solve trigonometric equations and verify trigonometric identities
P17 Understand connections between trigonometric, exponential, and logarithmic functions and polar coordinates, complex numbers, and series
P18 Model real-world phenomena with a variety of functions
P19 Graph using polar coordinates
P20 Explore graphs in three dimensions
P21 Explore functions of several variables
P22 Explore recursive functions using spreadsheets and/or programming languages

Unit: Science Literacy

NOTE: This content was extracted from the 9-12 cluster of Ohio's Draft Model Science Program. Due to statewide initiatives other than Tech Prep, this literacy unit was not altered to meet competency-based criteria. Each literacy unit forms a critical link between academic teachers and members of business, industry, and labor. [See "The TCP Process" for more information.]

Subunit: Scientific Inquiry

Competencies:

Q1 Check the appropriateness and accuracy of measures and computations using various strategies (e.g., estimations, unit analysis, determination of significant figures)

Q2 Use ratios, proportions, and probabilities in appropriate problem situations

Q3 Translate information from and represent information in various forms with equal ease (e.g., tables, charts, graphs, diagrams, geometric figures)

Q4 Use existing algebraic formulas and create new ones in appropriate problem-solving situations

Q5 Estimate and justify probabilities of outcomes of familiar situations based on experimentation and other strategies

Q6 Invent apparatus and mechanical tools needed to perform unique tasks in various situations

Q7 Identify, compare, and contrast different modes of inquiry, habits of mind, and attitudes and dispositions

Q8 Design investigations that are safe and ethical (i.e., obtain consent and inform others of potential outcomes, risks and benefits, and show evidence of concern for human health and safety, concern for non-human species)

Q9 Make and read scale drawings, maps, models, and other representations to aid planning and understanding

Q10 Seek elaboration and justification of data and ideas, and reflect on alternative interpretations of the information

Q11 Use appropriate units for counts and measures

Q12 Create and use databases (electronic and other) to collect, organize, and verify data and observations

Q13 Design and conduct investigations with multiple variables

Q14 Communicate the results of investigations clearly in a variety of situations

Subunit: Scientific Inquiry (continued)
Competencies:

Q15 Examine relationships in nature, offer alternative explanations for the observations, and collect evidence that can be used to help judge among explanations

Q16 Trace the development (e.g., history, controversy, and ramifications) of various theories, focusing on supporting evidence and modification with new evidence

Q17 Select, invent, and use tools, including analog and digital instruments, to make and record direct measurements

Q18 Observe and document events and characteristics of complex systems

Q19 Explain the influence of perspective (e.g., spatial, temporal, and social) on observation and subsequent interpretations

Q20 Create multiple representations of the same data using a variety of symbols, descriptive languages, mathematical concepts, and graphic techniques

Q21 Generate testable hypotheses for observations of complex systems and interactions

Q22 Document potentially hazardous conditions and associated risks in selected homes and public areas

Q23 Participate in public debates, relying on documented and verified data to construct and represent a position on scientific issues

Q24 Construct and test models of physical, biological, social, and geological systems

Q25 Read, verify, debate, and, where necessary, refute research published in popular or technical journals of science (e.g., *Discover*, *Omni*, *Popular Mechanics*)

Q26 Explore discrepant events and develop and test explanations of what was observed

Q27 Conduct theory-based research using surveys, observational instruments, and other methods

Q28 Modify personal opinions, interpretations, explanations, and conclusions based on new information

Q29 Analyze error and develop explanations in various domains

Q30 Formulate taxonomic schemes based upon multivariate models that help to explain similarities and differences in form, distribution, behavior, survival, and origin of objects and organisms

Q31 Demonstrate various logical connections between related concepts (e.g., entropy, conservation of energy)

Q32 Account for discrepancies between theories and observations

Q33 Analyze the changes within a system when inputs, outputs, and interactions are altered

Subunit: Scientific Inquiry (continued)
Competencies:

Q34 Create, standardize, and document procedures

Q35 Determine the sources of significant disparities between the predicted and recorded results and change research procedures to minimize disparities

Q36 Research, locate, and propose applications for abstract patterns (e.g., fractals, Fibonacci sequences, string theory, orbitals)

Q37 Recognize and utilize classification systems for particles, elements, compounds, phenomena, organisms, and others for exploring and predicting properties and behaviors

Q38 Suggest and defend alternative experimental designs and data explanations (e.g., sampling, controls, safeguards)

Q39 Recognize and communicate differences between questions that can be investigated in a scientific way and those that rely on other ways of knowing

Q40 Draw conclusions based on the relationships among data analysis, experimental design, and possible models and theories

Q41 Suggest new questions as a result of reflection on and discussions about their own scientific investigations

Q42 Investigate, assess, and comment on strengths and weakness of the descriptive and predictive powers of science

Q43 Create new information from representations of data in a variety of forms (e.g., symbols, descriptive languages, graphic formats) utilizing a variety of techniques (e.g., interpolations, extrapolations, linear regressions, central tendencies, correlation's)

Subunit: Scientific Knowledge
Competencies:

K1 Investigate various types of dynamic equilibrium (e.g., biological, geological, mechanical, chemical)

K2 Investigate the relationship between the rates of energy exchange and the relative energy level of components with systems (e.g., tropic levels of ecosystems, osmosis, rate of heating and cooling, storms)

K3 Investigate patterns in the natural world (e.g., heredity, crystalline structures, population and resource distributions, diffraction, dispersion, polarization)

K4 Investigate models and theories that help to explain the interactions of components in systems (e.g., conservation of mass, energy, and momentum; food webs; natural selection; entropy; plate tectonics; chaos; relativity; social-psychology)

K5 Investigate degrees of kinship among organisms and groups of organisms

K6 Investigate the limits of the definition of life, and investigate organisms and physical systems that exist at or near these limits (e.g. viruses, quarks, black holes)

K7 Investigate estimates and measurements of a wide range of distances and rates of change

K8 Investigate the historical development of theories of change over time (e.g., natural selection, continental drift, the big bang, geologic change)

K9 Investigate physical and chemical changes in living and non-living systems (e.g., photosynthesis, weathering processes, glaciation, thermal effects of materials, energy cells)

K10 Investigate simulations of nuclear change (e.g., radioactivity, half life, carbon dating)

K11 Investigate conservation principles associated with physical, chemical, and nuclear changes

K12 Formulate descriptions of the impacts of various forms of mechanical and electromagnetic waves on various organisms on each other over time

K13 Formulate models and hypotheses for patterns in the natural world (e.g., earth structures, transportation systems, migrations, communications, constellations)

K14 Formulate explanations for the influences of objects and organisms on each other over time

K15 Formulate and interpret explanations for change phenomena (e.g., mass extinction's, stellar evolution, punctuated equilibrium, molecular synthesis)

Subunit: Scientific Knowledge (continued)
Competencies:

K16 Formulate and interpret explanations for the magnitudes of diversity at different periods of geologic time (e.g., mutation, global cataclysms, continental drift, competition, mass extinction's)

K17 Formulate interpretations of the structure, function, and diversity in a variety of organisms and physical systems (e.g., DNA and RNA variants, nucleons, interaction particles)

K18 Formulate understandings of geologic time (e.g., millennia, periods, epochs)

K19 Formulate an understanding of the historical development of the model of the universe

K20 Formulate explanations and representations of the production, transmission, and conservation of energy in biological and physical systems (e.g., weather, volcanism, earthquakes, electricity, magnetism, cellular respiration)

K21 Formulate models and hypotheses about patterns in the natural world (e.g., social behavior, molecular structure, energy transformation, entropy, randomness, aging, chaos, hormonal cycles)

K22 Formulate interpretations of the relationship between energy exchange and the interfaces between components within systems

K23a Formulate estimations for the range of energies within and between various phenomena (e.g., thermal, electromagnetic, thermonuclear, chemical, electrical)

K23b Formulate explanations for the historical development of descriptions of motions interactions and transformations of matter and energy (e.g., classical Newtonian mechanics, special and general relativity, chaos)

K24 Formulate models that can be used to describe fundamental molecular interactions in living and non-living systems (e.g., cell membranes, semiconductors).

K25 Formulate an understanding of the degree of relationship among organisms and objects based on molecular structure (e.g., proteins, nucleic acids)

K26 Formulate hypotheses and models that may account for observable events (e.g., electricity and magnetism, gravitation, atoms, bonding, chemical reactions, quantum effects, energy flow on biological systems, predator-prey relationships)

K27 Formulate models and hypotheses about change over time (e.g., natural selection, speciation, punctuated equilibrium, phyleytic gradualism, stellar evolution, plate tectonics, radioactive decay, quantum mechanical theory)

Subunit: Scientific Knowledge (continued)
Competencies:

K28 Formulate lists of limitations and propose refinements of standard classification systems (e.g., periodic table, IUPAC, Linnean, standard model)

K29 Formulate specific cases of limitations and possible exceptions of theories and principles regarding the interactions of moving objects and organisms (e.g., fluid flow in vessels, motion near the speed of light, Heisenberg uncertainty principle, meteorological prediction, local variation and diversity, predicting earthquakes, energy transport in cellular respiration)

K30 Formulate plans and contingencies that can be used to accommodate for changes to and stresses on systems (e.g., wildlife and habitat management, corrosion prevention, noise abatement, structure design)

K31 Formulate models of molecular, atomic, ionic, and subatomic structures and the physical and biological implications of these structures (e.g., genes, nucleons, quarks)

K32 Formulate estimates for a wide range of measurements and scales (e.g., angstroms to light years)

K33 Formulate and interpret representations of time from origin to present accounting for phenomena of scale (e.g., smoothness, punctuation's, chaos)

K34 Formulate interpretations of the historical development of various theories of possible causes of diversity among physical and biological phenomena (e.g., the works of Aristotle, Mendel, Darwin, McClintock)

K35 Formulate models and hypotheses that can be used to explain the interactions of components within technological and ecological systems

Subunit: Conditions for Learning Science

Competencies:

C1 Participate actively in dialogue about and resolution of community issues
C2 Assess information from various countries in the original language or translated form to ascertain the perspectives of many cultures
C3 Analyze the scientific ideas presented in science fiction stories and films
C4 Perform and repeat investigations to verify data, determine regularity, and reduce the impact of experimental error
C5 Present the results of investigations in a variety of forums
C6 Contribute to the decisions regarding topics for investigation
C7 Use various creative means to communicate interpretations of scientific ideas, concepts, phenomena, and events
C8 Consider the scientific thinking and language of others
C9 Individually and collaboratively produce clearly written representations of investigative results
C10 Fulfill responsibilities as part of a research group
C11 Select and utilize resources by various criteria (e.g., efficiency, effectiveness, health, safety) that are appropriate to the investigations being conducted by groups
C12 Present persuasive argument based on the scientific aspects of controversial issues
C13 Collect, store, retrieve, and manipulate information with available t technologies alleges that may range from hand processes up through computer applications
C14 Investigate social issues with a scientific perspective (e.g., human rights, wellness, economics, futurism, environmental ethics)
C15 Keep journals of observations and inferences made over an extended period of time and reflecting upon the impact of these recorded ideas on their thinking and actions
C16 Examine the intellect, perspectives, and ethics of notable scientists
C17 Collect and analyze observations made over extended periods of time and compare these to scientific theories
C18 Create presentations of scientific understandings using diverse modes of expressions
C19 Conduct formal scientific debates in the classroom
C20 Wonder about the likelihood of events that may occur by chance or coincidence
C21 Plan and conduct field trips and experiences for small and large groups
C22 Analyze the historical context which leads to and has lead to scientific t theories

Subunit: Conditions for Learning Science (continued)
Competencies:

C23 Seek information on topics of personal scientific interest from a variety of sources
C24 Conduct learner-developed investigations independently and collaboratively over periods of week and months
C25 Listen attentively and critically to presentations of scientific information made by others
C26 Conduct analyses of propaganda related to scientific issues
C27 Perform investigations that require observations over varying periods of time
C28 Experience scientific concepts as interpreted by other cultures through multimedia and local and global specialists
C29 Access appropriate technology to perform complicated, time-consuming tasks
C30 Relate historical accounts of science to the cultural context in which they were written
C31 Work as a contributing member of a collaborative research group
C32 Examine the influences of social and political structures and realities that contribute to inquiry about scientific issues
C33 Use technology (e.g., desktop publishing, teleconferencing, networking) to communicate scientific ideas
C34 Explore and analyze a variety of perspectives on science (e.g., works by men and women of many racial, ethnic, and cultural groups)
C35 Lead groups of learners of various ages in designing, planning, and conducting science activities
C36 Respect the scientific thinking of others and self
C37 Recognize and contrast different epistemologies
C38 Develop possible courses of action in response to scientific issues of local and global concern
C39 Determine the validity of research conclusions in relation to the design, performance, and results
C40 Develop multimedia presentations of group and individual research projects and investigations appropriate for a variety of audiences and forums
C41 Produce interesting and scientifically correct stories and present them using various modes of expression
C42 Reflect on the ideas and content found in their own journal records
C43 Examine ambiguous results and formulate explanations
C44 Recognize and synthesize the contributions to scientific thought of individuals from many cultures

Subunit: Conditions for Learning Science (continued)
Competencies:

C45 Construct models and simulations of the component structures and functions of living and non-living entities
C46 Lead multi-age groups in the examination of and planned resolution for scientific issues
C47 Recognize and choose members of research teams based upon the merit of their ideas and skills
C48 Construct a portfolio of products, documentation, and self-evaluations of his/her own abilities, skills, and experiences
C49 Synthesize scientific information from a variety of sources
C50 Evaluate and prioritize scientific issues based upon risk-benefit analyses
C51 Refining scientific skills from a variety of experiences

Subunit: Applications for Science Learning
Competencies:

A1 Answer student-determined questions by designing databases and drawing inferences from the analyses of the information in these data bases

A2 Make personal behavior decisions by interpreting information that has a scientific basis

A3 Propose courses of action that will validate and demonstrate personal understandings of scientific principles

A4 Guide other learners in their understanding of the interactions of technologies and society at various periods in time

A5 Promote and carry out practices that contribute to a sustainable environment

A6 Study and propose improvements in public services and systems in their community

A7 Choose consumer materials utilizing personal and environmental risk and benefit information

A8 Make inferences and draw conclusions using databases, spreadsheets, and other technologies

A9 Do simple trouble-shooting on common electrical and mechanical systems, identifying and eliminating possible causes of malfunctions

A10 Construct devices that perform simple, repetitive actions

A11 Investigate the functionality of various geometric shapes in the natural world and the designed world (e.g., translations from spherical to plane representations cause distortions, triangular shapes contribute to rigidity and stability in structures, round shapes minimize boundary for a given capacity)

A12 Make decisions regarding personal and public health

A13 Evaluate the social and ecological risks and benefits resulting from the use of various consumer products

A14 Analyze the contributions of advances in technology through history to his/her everyday life

A15 Identify and reduce risks and threats to a sustainable environment

A16 Extend the limits of human capabilities using technological enhancements

A17 Use and recognize various propaganda techniques

A18 Solve unique problems using the results of systematic analyses

A19 Choose everyday consumer products that utilize recent innovation and pass appropriate performance criteria

A20 Refine personal career interests through investigations of the diversity of manufacturing, research, service, and invention processes

Subunit: Applications for Science Learning (continued)
Competencies:

A21 Predict and investigate the working of toys and tools while controlling and manipulating variables (e.g., friction, gravity, forces)
A22 Write, follow, modify, and extend instructions (e.g., equations, algorithms, formulas, flow diagrams, illustrations)
A23 Create products, make inferences, and draw conclusions using databases, spreadsheets, and other technologies
A24 Predict various scenarios and propose solutions to community issues using scientific information (e.g., actuarial tables, census data, topographic maps, incidence data, climatic data)
A25 Use scientific evidence to consider options and formulate positions about the health and safety of others and him/herself
A26 Search for, use, create, and store objects and information using various strategies and methods of organization and access
A27 Research and write environmental impact statements of his/her own design
A28 Compare school-based science perspectives with those gained through cutting-edge technological applications
A29 Design management plans for natural and human-altered environments (e.g., woodlots, patios, lots, lawns, farmlands, forests)
A30 Refine personal career interests
A31 Promote public awareness of the interaction of technology with social i issues
A32 Advocate and propose courses of action for local and global scientific issues using global networks
A33 Use appropriate technologies to prepare and present the findings of investigations incorporating tables, graphs, diagrams, and text
A34 Make informed consumer choices by evaluating and prioritizing information, evidence, and strategies
A35 Develop an informed point-of-view that allows for validation or refutation of the scientific statements and claims of advocated before pursuing courses of action (e.g., contributing support, signing petitions, casting votes)
A36 Differentiate between observations and inferences in the exploration of evidence related to personal, scientific, and community issues
A37 Develop and write environmental impact and safety and hygiene management plans
A38 Use technology to collect, analyze, and communicate information (e.g., electronic networks, desktop publishing, remote sensing, graphing calculators, satellite telemetry, and others)
A39 Design, construct, and market inventions

Unit: Technology Literacy

NOTE: Over 500 Ohio business, industry, and labor representatives examined, altered, and then verified the content for this unit during the TCP Process. The original content was extracted from the Report of the Task Force on Technology Competence—Learner Goals for All Minnesotans, published by the Minnesota State Council on Vocational Technical Education. The Technology Literacy unit forms a critical link between all teachers and stresses the importance of technological impact on teaching and learning. [See "The TCP Process" for more information.]

Competencies:

T1 Demonstrate a systems view of technology based on the interdependence of social, political, economic, and ecological systems
T2 Assess the career, family, and personal development implications of technological change
T3 Demonstrate continuous learning via technology
T4 Demonstrate global appreciation for technology's potential effects on cultures, geographic areas, and the environment
T5 Apply historical perspective on technology to the development and use of new technologies
T6 Apply diverse technologies to store, access, process, create, and communicate information needed to solve problems
T7 Apply legal principles and ethical conduct to the use of technology
T8 Demonstrate competency in mathematics, science, social sciences, communication, and computer skills through the analysis, design, and evaluation of technological systems
T9 Analyze the potential of alternative technological systems to solve problems and/or to extend human capabilities
T10 Use a variety of tools, materials, and equipment in solving problems and extending human capabilities
T11 Assess risks and benefits of technological developments from an ecological, economic, social, and political perspective
T12 Value human diversity as part of a team in suggesting, designing, and testing solutions to technological problems

Unit: Employability Skills

Competency: Develop a career plan

Competency Builders:

Identify current interests and aptitudes
Identify common barriers to employment
Describe strategies to overcome employment barriers
Locate resources for finding employment
Research job trends
Identify career options
Identify advantages and disadvantages of career options (in addition to other than monetary)
Identify job requirements
Investigate education/training opportunities
Evaluate personal strengths and weaknesses

Competency: Prepare for employment

Competency Builders:

Identify traditional and non-traditional employment sources
Identify present and future employment opportunities (by geographic location)
Research job opportunities, including non-traditional careers
Compare salary ranges and benefit packages
Compile occupational profile
Identify rights and responsibilities of equal employment opportunity laws
Design resume and cover letter
Target resume
Secure references
Investigate generic and specific employment tests (e.g., civil service exam; drug screening)
Use follow-up techniques to enhance employment potential
Demonstrate legible written communication skills using correct grammar, spelling, punctuation, and concise wording
Describe methods for handling illegal questions on job application forms and during interviews
Write letter of application
Research prospective employer and services performed
Explain critical importance of personal appearance, hygiene, and demeanor
Interpret job description
Demonstrate appropriate interview question and answer techniques
Demonstrate methods for handling difficult interview questions
Evaluate job offers
Write letter of acceptance
Write letter of declination
Demonstrate good listening skills
Ask for the job tactfully
Participate in extracurricular activities (e.g., student government, community projects,)

Competency: Evaluate the importance of self-esteem as an employability skill

Competency Builders:

Identify factors that affect self-esteem
Compare effects of low self-esteem and high self-esteem
Identify strategies to promote positive self-esteem

Competency: Demonstrate job retention skills

Competency Builders:

Identify employer expectations regarding job performance, work habits, attitudes, personal appearance, and hygiene
Exhibit appropriate work habits and attitude
Demonstrate ability to set priorities
Identify behaviors to establish successful working relationships
Identify alternatives for dealing with harassment, bias, and discrimination based on race, color, national origin, sex, religion, handicap, or age
Identify opportunities for advancement
List reasons for termination
List consequences of being absent frequently from job
List consequences of frequently arriving late for work
Demonstrate interpersonal relations skills (i.e., verbal and written)
Demonstrate negotiation skills
Demonstrate teamwork
Follow chain-of-command
Exhibit appropriate job dedication

Competency: Demonstrate knowledge of work ethic

Competency Builders:

Define work ethic
Identify factors that influence work ethic
Differentiate law and ethics
Describe how personal values are reflected in work ethic
Describe how interactions in the workplace affect personal work ethic
Describe how life changes affect personal work ethic

Competency: Exhibit appropriate work ethic

Competency Builders:

Use time-management techniques
Avoid personal activity during work hours
Attend work as scheduled
Adhere to company and/or governmental policies, procedures, rules, and regulations
Exercise confidentiality
Demonstrate appropriate human relations skills
Adhere to rules of conduct
Accept constructive criticism
Offer constructive criticism
Take pride in work
Resolve conflict
Manage stress
Avoid sexual connotations and harassment
Adjust to changes in the workplace
Demonstrate punctuality
Assume responsibility for personal decisions and actions
Take responsibility for assignments
Follow chain-of-command

Competency: Apply decision-making techniques

Competency Builders:

Identify decision to be made
Identify ownership of decision to be made
Identify possible alternatives and their consequences
Make decisions based on facts, legality, ethics, goals, and/or culture
Apply time factor(s)
Present decision to be implemented
Evaluate decision made
Take responsibility for decision

Competency: Apply problem-solving techniques

Competency Builders:

Identify problem
Select appropriate problem solving tools/techniques
Identify root problem cause(s)
Track root problem cause(s)
Identify possible solutions and their consequences (e.g., long term, short term, crisis)
Use resources to explore possible solutions to problem
Contrast advantages and disadvantages of each solution
Identify appropriate action
Evaluate results
Identify post-preventive action

Competency: Exhibit characteristics for job advancement

Competency Builders:

Display positive attitude
Demonstrate knowledge of position
Perform quality work
Adapt to changing situations and technology
Demonstrate capability/responsibility for different positions
Identify characteristics of effective leaders
Identify opportunities for leadership in work place/community
Demonstrate initiative to affect change in workplace
Participate in continuing education/training program
Responds appropriately to criticism from employer, supervisor, or other employees
Exhibit awareness of corporate culture
Prepare for job setbacks
Exhibit continual growth based on performance evaluation
Set realistic goals

Unit: Professionalism

Competency: Project professional image

Competency Builders:

Define professionalism
Exhibit professional appearance
Exhibit professional manners
Project professional attitude
Identify individuals' vital role in organization
Exhibit proper etiquette in professionally-related situations

Competency: Achieve individual and professional goals

Competency Builders:

Set flexible, realistic, and measurable goals
Identify potential barriers to achieving goals
Identify strategies for addressing barriers to goal achievement
Breakdown long-term goals into short-term goals
Prioritize goals
Commit to goals
Adjust goals
Obtain support for goals
Reward goal achievement

Competency: Manage personal finances

Competency Builders:

Explain need for personal management records
Balance checkbook
Identify tax obligations
Analyze how credit affects financial security
Compare types and methods of investments
Compare types and methods of borrowing
Compare types and methods of insurance
Compare types of retirement options/plans
Identify discriminatory vs. non-discriminatory expenditures

Competency: Support community well-being

Competency Builders:

Identify environmental, educational, and social issues
Participate in social and/or community activities

Competency: Achieve organizational goals

Competency Builders:

Evaluate personal goals in relation to organizational goals
Monitor progress by evaluating feedback
List responsibilities in relation to organization goals
Accomplish assigned tasks
Exercise responsibility in relation to organizational goals
Set appropriate personal performance standards
Communicate goals with supervisor and peers
Demonstrate knowledge of products and services
Promote organizational image and mission

Competency: Demonstrate positive relations in the workplace

Competency Builders:

Identify personality types of self and other
Identify various management styles
Support employer expectations
Support employer decisions
Accept constructive criticism
Give constructive feedback
Adapt to changes in workplace
List factors to consider before resigning
Write letter of resignation

Competency: Manage stressful situations

Competency Builders:

Accept stress as part of daily life
Identify personal and professional factors contributing to stress
Describe physical and emotional responses to stress
Evaluate positive and negative effects of stress on productivity
Identify strategies for reducing stress
Implement strategies to manage stress
Create strategies for developing and maintaining support systems

Competency: Analyze effects of family on work and work on family

Competency Builders:

Identify how family values, goals, and priorities are reflected in work place
Identify responsibilities and rewards associated with paid and non-paid work
Identify responsibilities and rewards associated with families
Explain how family responsibilities can conflict with work
Explain how work can conflict with family responsibilities
Explain how work-related stress can affect families
Explain how family-related stress can affect work
Identify family support systems and resources
Identify work-related support systems and resources
Communicate with family regarding work

Competency: Apply lifelong learning skills

Competency Builders:

Define lifelong learning
Identify factors that cause need for lifelong learning
Analyze effects of change
Identify reasons why goals change
Describe importance of flexibility and adaptability
Evaluate need for continuing education/training

Competency: Manage professional development

Competency Builders:

Identify career opportunities
Modify career plan
Participate in continuing education/training opportunities
Document continuing education/training
Read profession-related manuals, technical journals, and periodicals
Attend meetings, workshops, seminars, conferences, and demonstrations
Participate in professional organizations
Build personal/professional mentor relationship
Build personal/professional support system
Build professional network
Strengthen communication skills
Strengthen leadership skills
Strengthen management skills

Unit: Teamwork

Competency: Demonstrate knowledge of teamwork

Competency Builders:

Define empowerment
Differentiate work groups and teams
Identify conditions essential to teamwork (e.g., brainstorming)
Explain influence of culture (e.g., corporate, community) on teamwork
Identify appropriate situations for using teams
Define team structures (e.g., cross functional, quality improvement, task force, quality circles)
Identify team building concepts
Describe characteristics and dynamics of teams
Identify characteristics of effective team leaders and members
Identify responsibilities of a valuable team member
Identify methods of involving each member of a team
Explain how individuals from various backgrounds contribute to work-related situations (e.g., technical training, cultural heritage)
Explain the purpose of facilitators
Define consensus
Define reward/recognition system

Competency: Demonstrate teamwork

Competency Builders:

Identify purpose of team and intended goal (include time frames)
Structure team around purpose
Define responsibilities of team members
Contribute to efficiency and success of team
Work toward individual and team milestones
Analyze results of team project
Facilitate a team meeting
Assist team member(s) with problem
Monitor time frame
Stress continuous improvement
Accept failure as part of learning

Competency: Use teamwork to solve problems

Competency Builders:

Identify appropriate situations for using teams
Use problem-solving process in a team setting
Identify quality management processes/techniques
Identify quality assurance processes/techniques
Prepare presentation

Competency: Conduct team meetings

Competency Builders:

Plan agenda
Schedule meeting and location
Invite appropriate personnel
Solicit outside speakers as needed
Assign someone to take minutes
Facilitate introductions
Invite questions and comments and group participation
Focus team on agenda items
Assign appropriate action, time frame and accountability to tasks
Monitor time
Close meeting on time
Publish minutes in timely manner
Set ground rules
Avoid placing individual agendas above the group's agenda

Unit: Quality Assurance

Competency: Demonstrate knowledge of quality assurance

Competency Builders:

Explain the historical evolution of quality assurance (e.g., Deming, ISO 9000)
Explain changes brought about by quality leaders in the world
Explain the ISO 9000 process
Define quality terms
Define quality functions
Identify features of quality planning
Describe control devices used in functional areas (e.g., SPC, equipment)
Explain the relationship among organizational structures, policies, procedures, and quality assurance
Explain importance of internal and external customers
Identify internal and external customers
Describe successful efforts by industry to improve quality and/or reduce costs
Differentiate prevention and detection
Differentiate variable and attribute data
Identify types of coontrol charts
Explain how statistical techniques are tools used to control quality (e.g., SPC, DOE, CR)

Competency: **Demonstrate knowledge of quality cost implications**

Competency Builders:

Identify cost/quality objectives
Classify costs (i.e., direct and indirect, fixed and variable, methods and standards)
Classify quality costs (i.e., prevention, evaluation, pre-delivery failure, post-delivery failure)
Define produce liability
Interpret quality cost reports
Explain consumerism and liability prevention
Define safety terms of product
Identify safety responsibility within organization
Define contracts and torts
Differentiate express and implied warranty
Differentiate warranty and product liability
Explain how warranties are part of contract law
List questions that would need answering in liability claim

Competency: **Demonstrate knowledge of engineering a quality product**

Competency Builders:

Associate customer satisfaction with product characteristics (e.g., usefulness, price, operation, life, reliability, safety, cost of operation)
Define manufacturability
Identify steps in product design (e.g., brainstorming, thumbnail sketches, rendering)
Define reliability factors (e.g., cost, human, producibility)
Identify ways reliability is achieved (e.g., maintainability, good design, design simplification, design redundancy)
Explain the relationship of maintainability to reliability
Define failure
Explain the role of testing and reliability
Define value engineering
Define quality objectives
Identify cost components as they relate to quality objectives
Classify quality costs (i.e. preventive, evaluation, pre-delivery failures, post delivery failures)
Describe predictive maintenance

Competency: **Explain importance of interdepartmental relationships to quality assurance**

Competency Builders:

Explain need for everyone's commitment in assuring quality
Explain phrase "Everyone is a customer/supplier"
Define quality improvement team models
Explain the importance of top management's support of quality
Explain project selection
Explain project implementation
Explain project evaluation
Explain continuing improvement
Describe future trend of experiment design
Describe future trend of predictive maintenance

Competency: **Manipulate quality cost data**

Competency Builders:

Develop quality cost data
Translate cost reports
Graph quality cost data (e.g., pareto)

Competency: **Manipulate cost control data**

Competency Builders:

Develop cost control data
Analyze cost control reports
Provide cost control data
Provide advice on "Make or Buy" decisions (including economical lot size decisions)

Competency: Demonstrate knowledge of basic statistics

Competency Builders:

Describe data collection methods
Collect data
Organize data by flow chart
Interpret data by cause and effect diagrams
Define nominal, ordinal, interval, and ratio data
Define mean, median, and mode
Explain significance of standard deviation
Explain normal distribution

Competency: Demonstrate knowledge of scattergrams

Competency Builders:

Construct scattergram
Interpret for positive, negative, or no correlation between X and Y variables
Test for significance between one and five percent
Explain regression analysis

Competency: Demonstrate knowledge of probability theory

Competency Builders:

Define classical probability
Define empirical probability
Calculate probability for outcomes

Competency: **Demonstrate knowledge of precontrol**

Competency Builders:

Explain uses of precontrol
Calculate precontrol limits
Explain significance of the limits
Plot values on a precontrol chart
Explain "out-of-control" situation
Make decisions on green, yellow and red conditions

Competency: **Demonstrate knowledge of process capability**

Competency Builders:

Use X, R, USL, and LSL to determine process capability (upper and lower specification limits)
Calculate estimated process standard deviation
Plot right hand and left hand tail of process variation
Compute Z value for percent of probable defect for process
Calculate C_{PK} values that describe process capability
Describe skewed distributions
List probable causes of skewed distribution

Competency: Use quality control charts

Competency Builders:

Identify operational definitions for attribute criteria
Interpret histogram
Interpret scattergrams
Interpret NP chart
Interpret P chart
Interpret flowchart
Interpret cause-and-effect diagram
Construct P (percentage defective) chart for attributes
Plot control limits of P chart and data points
Check chart for out-of-control conditions
Construct an NP (number defective) chart with control limits and data
Construct C (count of defects) and U (number of defects per unit) charts
Check data on C and U charts
Construct flowchart
Construct cause-and-effect chart

Competency: Interpret $\overline{X}$ and R charts

Competency Builders:

Plot percentages for normal distribution
Test distribution for normality
Explain difference between common cause and special cause
Define an "in-control" process
Explain significance of an out-of-control point on $\overline{X}$ or R chart
Identify patterns and trends on control chart
Identify run up and run down
Test for middle third on control chart
Explain significance of middle third on control chart
Explain Rule of Sevens

Competency: Construct $\bar{X}$ and R charts

Competency Builders:

Arrange data into statistical sub-groups
Explain importance of random sampling
Compute $\bar{X}$ (i.e., average of values) and R (i.e., range of values in subgroup) within sample
Plot in $\bar{X}$ and R on chart
Construct control chart with $\bar{\bar{X}}$ (grand average) and $\bar{R}$ (average range) calculated
Calculate upper and lower control limits for $\bar{X}$-chart
Calculate upper and lower control limits for R-chart

Competency: Conduct process improvement studies

Competency Builders:

Analyze production methods and processes applying statistical process improvement techniques (e.g., SPC, C_{PK})
Identify appropriate statistical techniques for study (e.g., T-tests, F-test, capability, DOEX)
Identify major steps in conducting a study
Define "report" for a study (e.g., goal, objective, study conduct, results, conclusions, discussions)
Integrate results into the total system

Competency: Demonstrate knowledge of JIT

Competency Builders:

Define just-in-time concept (JIT)
Describe various production methodologies (e.g., standard cycle times, routings, standard quantities, multiple-machine tending)
Describe types of inventory control (e.g., Kanban)
Describe importance of flexibility
Differentiate product layout, process layout, fixed position layout, and cellular layout
Differentiate straight-line, U-shaped, S-shaped, convoluted and comb patterns
Describe advantages/disadvantages of layout and patterns
Explain importance of product protection, identification and storage
List methods of identifying products (e.g., labels, bar codes, radio frequency systems and magnetic strip systems)
Describe manual methods of storage and retrieval
Describe automated storage and retrieval systems (ASRS)
Describe automated guided vehicle moving systems (AGVS)

Competency: Apply JIT

Comptency Builders:

Maintain system for physical handling and movement of material in-process and in-storage
Monitor system of physical handling and movement of material in-process and in-storage
Maintain system for physical handling and movement of finished products
Monitor system of physical handling and movement of finished products
Write requests for deviation from specifications
Implement quality control and inspection standards and procedures
Write engineering change notices and rejection reports
Monitor reports of discrepancy or rejects during production process
Conduct quality tests under different environmental conditions

Competency: Demonstrate knowledge of inspection

Competency Builders:

Explain purpose of inspection
Describe scope of inspection
Explain purpose of incoming, ongoing, and final inspections
Explain early detection inspection
Explain how statistical process control (SPC) aids inspection
Define types of nonconformance
Define degrees of nonconformance
Define corrective action
Describe when to 100% inspect
Describe when to sample inspect
Describe methods of testing for material properties (e.g., harness, strength, chemical makeup, flaws, errors in tooling or setup)
Define rework, salvage, and scrap
Describe ethical decisions an inspector may make
Identify purposes of computer-automated inspection
Explain advantages and limitations of automated inspection
Explain disposition of non-conforming material
Explain basic foolproofing concept to build inspection into process (i.e., poka-yoke)
Use checksheets to organize and record inspection results

Competency: Inspect machinery, materials, and products

Competency Builders:

Identify critical material characteristics from specification(s) or drawing(s)
Perform capability studies for machinery and materials acceptance
Identify appropriate acceptance sampling plan
Conduct incoming materials inspection using sampling plan criteria
Identify critical in-process characteristics from specification(s) or drawing(s)
Demonstrate basic metrology skills
Conduct in-process inspection
Identify appropriate inspection reports and follow-up
Gauge R and R (reproducibility and repeatability)
Apply geometric tolerancing
Explain C = O (zero) acceptance plan
Interpret instructions in a control plan

Competency: **Demonstrate knowledge of nondestructive testing**

Competency Builders:

Describe purpose of nondestructive testing
Identify anomalies
Define defects and discontinuities
Identify factors contributing to defects and discontinuities
Describe ultrasonic testing
Describe advantages and limitations of ultrasonic testing
Describe industrial radiography
Compare use of wet and dry particles in magnetic particle inspection
Explain advantages and limitations of penetrant inspection
Describe microwave testing
Describe holographic inspection
Explain choice of most suitable nondestructive test method
Describe eddy-current testing

Unit: Technical Recording and Reporting

Competency: Demonstrate proficiency in technical recording

Competency Builders:

Describe various documentation procedures
Interpret specifications or drawings
Observe process
Ask open-ended questions
Record process (e.g., flowchart, step-by-step)
Identify parameters
Record accurate, truthful data
Maintain test logs
Compile cumulative reference notebook/record
Measure appropriate parameters
Draft preventive maintenance and calibration procedures

Competency: Demonstrate proficiency in technical reporting

Competency Builders:

Use data books and cross reference/technical manuals
Compose technical memoranda
Identify type of report or format needed
Use appropriate format
Compile relevant data
Design charts and graphs
Analyze data
Draw conclusions
Explain analytical methods used
Outline reports
Write reports
Present reports

Unit: Computer Literacy

Competency: Describe personal computer operations

Competency Builders:

Explain how data is stored in main computer memory
Explain how computer system executes program instruction
Explain computer storage capacity
Explain how data is represented
Describe data storage techniques
Identify types of memory

Competency: Explain information processing cycle

Competency Builders:

Define operating systems (e.g., DOS, OS/2, UNIX, MAC)
Describe computer languages and their use
Describe computer languages and their use
Describe computer languages and their use
Describe difference between data files and program files
Explain PC layout
Explain PC network layout
Explain mini/mainframe network layout
Differentiate hardware and software
Differentiate open from proprietary architecture

Competency: Operate computer hardware

Competency Builders:

Practice proper media handling techniques (e.g., magnetic fields, dust, liquids)
Identify hardware and its use
Use hardware (e.g., mouse, diskettes, drive, modems, touch screen, printers, digitizers, scanners, cables, protection devices)
Keyboard efficiently
Demonstrate basic care of hardware
Explain need for and application of security levels/procedures
Perform basic hardware troubleshooting
Explain hardware addressing techniques

Competency: Use software

Competency Builders:

Define software types and functions
Describe basic disk operations and care
Perform functions necessary to operate software
List advantages and disadvantages of integrated and dedicated software
Operate system software
Operate diagnostic software
Demonstrate basic proficiency in spreadsheet use
Demonstrate basic proficiency in word processing
Demonstrate basic proficiency in database use
Demonstrate basic proficiency in network use
Demonstrate basic proficiency of utility (e.g., WINDOWS, GUI)
Demonstrate basic proficiency in report writing
Demonstrate system commands
Differentiate ethical use/misuse of software
Describe bulletin boards/electronic mail
Apply security levels/procedures while handling sensitive data
Explain data compression techniques
Explain use and deletion of passwords

Unit: Workplace Safety

Competency: Apply general safety precautions

Competency Builders:

Identify local, state, and federal rules and regulations
Identify personal protective wear and equipment
Identify visual controls (e.g., monitors, read outs)
Identify auditory controls
Identify common sense housekeeping
Interpret hazardous materials notices on containers
Use personal protective wear and equipment
Apply workplace safety rules and procedures
Apply personal safety rules and procedures
Apply workplace organization (e.g., housekeeping)
Apply applicable electrical, mechanical, steam, hydraulic and (e.g., pneumatic safety rules and procedures)
Apply fire safety rules and procedures
Apply hazardous wastes rules and procedures
Apply first aid
Locate (MSDS)
Perform lockout and tagout
Recycle scrap metal, chips, shavings, coolants, solvents, trash, and waste materials
Apply common sense housekeeping
Use preventive maintenance checklists

Competency: Demonstrate knowledge of safety and workplace hazards

Competency Builders:

Describe corrective procedures for unsafe conditions
Identify types and potential level of workplace hazards (e.g., physical hazards, fire, chemicals, noise, ionizing radiation, ultraviolet, temperature extremes, ergonomics, biological hazards)
Identify safety materials/equipment (e.g., absorbant socks, oil dry)
Interpret Material Safety Data Sheets (MSDS)
Explain purpose(s) of OSHA and NIOSH
Explain purpose(s) of NEC and NFPA
Identify purpose of emergency evacuation routes, master switch and lockout locations, and safety color coding systems
Identify roles of industrial hygienists, safety professionals, occupational physicians, and occupational nurses
Describe methods of evaluating potential hazards (e.g., visual analysis)
Describe methods of correcting potential hazards
Describe various types of toxicity (e.g., chronic, immediate)
Identify need for reporting accidents
Explain precautions required when using toxic or flammable materials
Define confined space and related requirements
Explain how international directives relate to safety

Competency: Explain purpose of industrial pollution control systems

Competency Builders:

Describe types of air, water, solid waste, and noise pollution
Explain purpose of air pollution control systems
Explain purpose of water pollution control systems
Explain purpose of solid waste pollution control systems
Explain purpose of noise pollution control systems
Explain basic philosophy of "right to know" legislation
Explain purpose(s) of EPA
Identify "costs" of industrial pollution control (i.e., dollars vs. impact to environment)
Describe ethics of environmental issues

Competency: **Demonstrate knowledge of ergonomics**

Competency Builders:

Define ergonomics
Define risk factor
Define maximum permissible limit (MPL) and action limit (AL) for lifting
Define cumulative trauma disorder (CTD)
Identify susceptibility factors for CTD
Minimize extreme joint movement
Minimize use of excessive muscle force
Minimize repetitive tasks
Minimize mechanical stresses (e.g., sharp edges, heat, cold, hard surfaces, weights, vibration)
Minimize awkward body positions
Explain use of rest pauses
Explain need for mats and footrest for standing jobs
Explain need for appropriate working heights of chairs, stools, workbenches, equipment
Explain need for adequate lighting
Explain use of anthropometric (i.e., centering one's view of everything around man) design

Unit: Supervision

Competency: Perform supervisory functions

Competency Builders:

Define supervision
Conduct task analysis
Create organizational and/or departmental charts
Apply company policies and procedures
Maintain workplace procedures manuals
Prepare budgets
Monitor budgets
Prepare managerial reports
Analyze daily production reports
Maintain appropriate work environment
Conduct tours
Facilitate assignments
Assign work
Delegate job tasks
Monitor progress
Prepare productivity reports
Provide training for new policies
Troubleshoot workplace problems
Coordinate workplace activities
Appraise performance
Document personnel issues
Coordinate administrative duties

Competency: Coordinate training

Competency Builders:

Assess training needs
Secure training resources, materials and equipment
Train employees
Evaluate progress of trainee
Provide feedback
Solicit feedback
Receive feedback
Assess feedback

Unit: Basic Electronics

Competency: **Demonstrate proficiency in electronics fundamentals**

Competency Builders:

Identify electronic components and schematic symbols
Describe basic atomic structure and its relationship to electricity
Describe the relationship between electrical and magnetic properties
Describe the electrical and magnetic properties of a magnet
Describe the photoelectric effect
Describe the thermocouple effect
Describe the electrical effect of friction
Use metric units to solve electronic unit problems
Identify sources of electricity
Describe principles and operations of electrochemical supplies
Describe voltage, current, resistance, power, and energy
Apply Ohm's Law
Apply Kirchoff's Laws
Apply power formulas
Explain Thevenin's Theorem
Explain Norton's Theorem
Interpret color codes and symbols to identify electrical components and values
Measure properties of circuits using test equipment
Describe electrostatic discharge (ESD) procedures

Competency: **Demonstrate proficiency in DC circuits**

Competency Builders:

Compute conductance of conductors and insulators
Measure resistance and current of conductors and insulators
Measure properties of a circuit using volt-ohm meter (VOM) and digital volt-ohm meter (DVM)
Build series, parallel, and combination circuits
Build bridge circuits
Build voltage divider circuits (loaded and unloaded)
Compute voltage divider circuits (loaded and unloaded)
Demonstrate maximum power transfer theory
Describe magnetic properties of circuits and devices
Explain physical and electrical characteristics of capacitors and inductors
Describe RC and RL time constants
Compute RC and RL time constants
Demonstrate use of diodes in DC circuits
Identify need for rectification
Operate power supplies for DC circuits
Analyze frequency spectrums
Construct the operation of DC circuits that demonstrate maximum power transfer theory
Use meters and oscilloscopes
Measure current, voltage, and resistance in DC circuits
Explain simple DC generator action
Explain simple DC motor action
Explain principals of solid-state switching devices
Solve algebraic problems to include exponential (prerequisite to DC) (algebraic calculation)
Explain use of DC in relation to communications
Identify classes, voltage ratings and/or polarity of electronic components
Identify use of circuit protective devices (e.g., fuses, breakers)
Troubleshoot DC circuits

Competency: Demonstrate proficiency in AC circuits

Competency Builders:

Analyze properties of an AC signal
Describe principles and operation of characteristics of sinusoidal and non-sinusoidal wave forms
Identify AC sources
Describe principles and operation of characteristics of capacitive circuits
Operate capacitive circuits
Describe principles and operation of characteristics of inductive circuits
Operate inductive circuits
Describe principles and operation of transformers
Demonstrate operation of AC circuits utilizing transformers
Use maximum power transfer theorems
Use Thevenin's and Norton's theorem to analyze AC circuits
Measure power in AC circuits
Operate capacitor and inductor analyzers for AC circuits
Operate differentiators and integrators to determine RC and RL time constants
Describe principles and operation of characteristics of series and parallel resonant circuits
Build series and parallel resonant circuits
Identify classes, voltage, ratings and/or polarity of electronic components
Identify use of circuit protective devices (e.g., fuses, breakers)
Describe principles and operation of characteristics of frequency selective filter circuits
Calculate logarithmic to obtain gain (dB) using tables or calculator/computer
Operate frequency selective filter circuits
Operate polyphase circuits
Describe basic motor theory and operation
Describe basic generator theory and operation
Operate power supplies for AC circuits
Describe principles and operation of various power conditioning (e.g., isolation transformers, surge suppressors, uninterruptable power systems)
Describe principles and operation of various safety grounding systems (e.g., lightning arresters, ground electrostatic discharge, fault interrupters, etc.)
Describe characteristics of inductors in series and parallel circuits
Describe characteristics of capacitance in series and parallel circuits
Compare resistive-capacitive (RC) and resistive-inductive (RL) time constants (TC)
Measure voltage, current, time, frequency (f), and phase relationships of AC sine wave signal
Describe frequency (F) and phase relationships

Describe resonance of inductive-capacitive (LC) circuits
Calculate impedance match and maximum transfer of power
Measure current, voltage, and resistance in AC circuits
Identify 50/60 Hertz
Explain simple AC generator action
Explain simple AC motor action
Calculate power factor in AC circuits
Explain harmonics and its effects on power quality
Solve basic trigonometric problems as applicable to electronics
Calculate peak (PK), root mean square (RMS), and average values
Troubleshoot AC circuits

Unit: Fundamentals of Electronics Technology

Competency: **Demonstrate proficiency in discrete solid-state devices**

Competency Builders:

Describe properties of semiconductor materials
Describe operating characteristics and applications of PN junctions
Demonstrate operation of diode circuits
Troubleshoot diode circuits
Repair diode circuits
Describe operating characteristics and applications of bipolar transistors
Describe operating characteristics and applications of field effect transistors
    (e.g., FET + s/MOSFET + s)
Describe operating characteristics and application of special diodes/transistors
Describe operating characteristics and applications of opto-electronic devices
    (e.g., gate isolators, interrupt sensors, infrared sensors)
Describe operating characteristics and applications of single-stage amplifiers
Demonstrate the operation of the single-stage amplifiers
Troubleshoot single-stage amplifiers
Repair single-stage amplifiers
Demonstrate the operation of thyristor circuitry (SCR, TRIAC, DIAC, etc.)
Troubleshoot thyristor circuitry (SCR, TRIAC, DIAC, etc.)
Operate analog and digital equipment for solid-state devices
Operate power supplies for solid-state devices
Operate oscilloscopes for solid-state devices
Operate function generators for solid-state devices
Operate curve tracers
Operate transistor testers

Competency: Demonstrate proficiency in analog circuits

Competency Builders:

Operate measuring instruments for analog circuits
Describe operating characteristics and applications of linear integrated circuits
Describe operating characteristics and applications of power supplies and filters
Describe operating characteristics and applications of operational amplifier circuits
Demonstrate the operation of operational amplifier circuits
Describe the operating characteristics and applications of regulated and switching power supply circuits
Demonstrate the operation of regulated power supply circuits
Describe operating characteristics and applications of active filters
Demonstrate the operation of active filter circuits
Describe operating characteristics and applications of sinusoidal and non-sinusoidal oscillator circuits
Demonstrate the operation of oscillator circuits
Describe the operating characteristics and applications of motor phase-shift control circuits (single-phase and multi-phase)
Describe the operating characteristics and applications of cathode ray tubes

Competency: Demonstrate proficiency in digital circuits

Competency Builders:

Operate logic problems for digital circuits
Operate power supplies for digital circuits
Operate pulsers for digital circuits
Operate oscilloscopes for digital circuits
Describe characteristics of integrated circuit (IC) logic families
Describe the principles and operation of types of logic gates and their truth tables
Demonstrate the use of logic gates
Describe the principles and operation of combinational logic circuits
Demonstrate the operation of combinational logic circuits
Describe the principles and operation of numbering systems, codes, and arithmetic operations
Minimize logic circuits using Boolean operations
Describe the principles and operation of types of flip-flops
Demonstrate the operation of flip-flops
Describe the principles and operation of types of registers and counters
Demonstrate the operation of registers and counters
Describe the principles and operation of clock and timing circuits
Demonstrate the operation of clock and timing circuits
Describe the principles and operation of types of arithmetic-logic circuits
Demonstrate the operation of arithmetic-logic circuits
Describe the principles and operation of types of encoders and decoders
Demonstrate the operation of encoders and decoders
Describe the principles and operation of types of multiplexer and demultiplexer circuits
Demonstrate the operation of multiplexer and demultiplexer circuits
Describe the principles and operation of digital-to-analog and analog-to-digital circuits
Demonstrate the operation of digital-to-analog and analog-to-digital circuits
Describe the principles and operation of types of digital display circuits
Demonstrate the operation of digital display circuits
Describe the types of digital display devices
Demonstrate the operation of digital display devices
Describe the operating characteristics and applications of fiber optics
Demonstrate the operation of fiber optics

Competency: **Demonstrate basic proficiency in microprocessors**

Competency Builders:

Describe the essential components of a microprocessor and their functions
Identify the levels of computer languages
Operate oscilloscopes and logic/data analyzers
Describe the principles and operation of BUS concepts
Describe the principles and operation of types of memory circuits
Demonstrate the operation of memory circuits
Troubleshoot memory circuits
Repair memory circuits
Describe microprocessor instruction sets
Describe the principles and operation of microprocessor machine code
Demonstrate the use of microprocessor machine code
Debug microprocessor machine code
Interface various types of peripherals
Describe the use of microprocessor simulator(s)

Competency: **Describe manufacturing of electronic devices and micromechanisms**

Competency Builders:

List properties of electronic packaging materials
Describe manufacturing of electronic products chips; integrated circuits; printed integrated circuits
Describe joining and assembly of electronic components
Describe coating and etching processes
List principles of packaging electronic components
Describe manufacture of miniature devices
Describe testing of joints
Describe reliability of electronic product testing
Describe the advantages and disadvantages of various advanced packaging techniques (e.g., SMD, MCM)
Describe methods of fabrication

Unit: Troubleshooting and Repair

Competency: **Demonstrate troubleshooting skills**

Competency Builders:

Explain role of preventive maintenance
Differentiate normal and abnormal operations
Explain troubleshooting procedures
Explain logical actions taken to troubleshoot
Use proper troubleshooting aids
Demonstrate knowledge of safety rules for troubleshooting and repair procedures
Maintain troubleshooting and repair records
Interpret prints (e.g., PID, loopsheets)
Use manufacturer's manuals, schematics, and troubleshooting charts
Isolate faults, shorts, and open circuits

Competency: **Apply troubleshooting techniques to DC circuits**

Competency Builders:

Identify noise problems
Isolate faults in series, parallel and series parallel
Isolate faults in bridge circuits
Isolate faults in DC power supplies
Perform polarity check
Isolate faults to DC drive system
Isolate faults in voltage divider circuits
Repair faults

Competency: **Apply troubleshooting techniques to AC circuits**

Competency Builders:

Isolate faults in capacitive circuits
Isolate faults in inductive circuits
Isolate faults in AC circuits utilizing transformers (e.g., step up and step down)
Isolate faults in differentiator and integrator circuits
Isolate faults in RC, RL, and RLC circuits
Isolate faults in frequency selective filter circuits
Isolate faults to AC frequency drive systems
Repair faults

Competency: **Apply troubleshooting techniques in discrete solid-state devices**

Competency Builders:

Isolate faults in diode circuits
Isolate faults in thyristor circuitry (e.g., SCR, TRIAC, DIAC)
Isolate faults in transistor circuits
Isolate faults in operational amplifier circuits
Isolate faults in single-stage amplifiers
Isolate faults in open circuits
Repair faults

Competency: **Apply troubleshooting techniques to analog circuits**

Competency Builders:

Isolate faults in single and multistage amplifiers
Isolate faults in audio power amplifiers
Isolate faults in regulated and switching power supply circuits
Isolate faults in active filter circuits
Isolate faults in oscillator circuits
Isolate faults in operational amplifier circuits
Isolate faults in power supplies (loaded and unloaded) and filters
Repair faults

Competency: **Apply troubleshooting techniques to digital circuits**

Competency Builders:

Identify noise problems
Isolate faults in multiplexer and demultiplexer circuits
Isolate faults in digital display circuits
Isolate faults in logic gates
Isolate faults in flip-flops
Isolate faults in registers and counters
Isolate faults in clock and timing circuits
Isolate faults in arithmetic-log circuits
Isolate faults in encoders and decoders
Isolate faults in digital-display devices
Repair faults

Competency: **Apply troubleshooting techniques to a microcomputer system**

Competency Builders:

Isolate faults to systems boards
Isolate faults to memory circuits
Isolate faults to data storage devices
Isolate faults in power supplies
Troubleshoot I/O ports
Isolate faults in I/O interface circuitry
Use diagnostic software
Repair faults

Competency: **Apply troubleshooting techniques to manufacturing systems**

Competency Builders:

Identify individual process blocks of assembly line or process
Identify process block interfaces
Demonstrate steps required for efficient systems troubleshooting
Isolate system faults to process block
Isolate block faults using schematics
Isolate block faults using programmable controller indicators
Isolate block faults using volt meter
Repair block faults by replacing fault component or wiring

Unit: Instrumentation Control Technology

Competency: Describe instrument loops

Competency Builders:

Use Instrumentation Society of America (ISA) symbology
Describe types of transmitters (e.g., flow, level, pressure, temperature)
Describe elements of a control loop (e.g., transmitter, indicator, controller, transducer, control valve)
Describe signals
Describe modes of control operation (e.g., manual, automatic, cascade, program)
Describe details of flow loop [e.g., orifice plate, segmental wedge, differential pressure transmitters (electronic and pneumatic), magnetic, turbine type transmitters, local indicators, controller, transducer, control valve]
Describe types of transmitters used in level control loops
Describe details of pressure transmitters
Describe details of temperature elements (thermocouples and RTD's) and transmitters
Describe details of infrared and photosensors
Describe details of proximity/vibration sensors
Describe details of speed/acceleration sensors
Describe details of resolver encoder
Describe details of linear voltage detection transformers (LVDT)

Competency: Calibrate loop elements

Competency Builders:

Identify manufacturer's requirements
Identify loop requirements
Verify function of test equipment
Set up test procedure
Perform calibration
Record results

Competency: Build control loops

Competency Builders:

Build flow loop
Build level control loop
Build pressure loop
Build temperature loop

Competency: Perform calculations

Competency Builders:

Calculate orifice plate sizing
Calculate flow transmitter differential pressure
Calculate control valve sizing

Competency: Describe distributed control systems

Competency Builders:

Describe various types of I/O
Describe various types of alarms
Describe system architecture

Competency: Describe types of controller action

Competency Builders:

Describe proportional control action
Describe proportional and integral control action
Describe proportional, integral, and derivative control action

Competency: Perform loop tuning

Competency Builders:

Troubleshoot loops
Demonstrate effect of using only a proportional parameter
Demonstrate effect of using only proportional and integral parameters
Demonstrate effect of various values for proportional, integral, and derivative tuning parameters
Demonstrate loop training using "open loop" step testing
Demonstrate loop tuning using Ziegler Nichols method

Unit: Industrial Electricity

Competency: Explain basic industrial electricity theory

Competency Builders:

Describe atomic structure and its relationship to electricity
Describe the relationship between electrical and magnetic properties
Describe the electrical and magnetic properties of a magnet
Describe the photoelectric effect
Describe the thermocouple effect
Describe the electrical effect of friction
Identify sources of electricity
Identify potential sources of electricity
Describe differences between AC/DC
Describe effects varying degrees of electricity have on the human body

Competency: Use the National Electrical Code (NEC)

Competency Builders:

Use NEC to identify correct materials
Use NEC to identify correct methods
Use NEC to identify correct applications
Use NEC to identify correct safety procedures

Competency: Explain operation of electrical distribution systems

Competency Builders:

Follow NFPA, local, state, and national codes
Describe functions of permits and licensing requirements
Explain generation of electricity
Explain transmission of electricity
Explain end user distribution

Competency: Maintain basic electrical systems

Competency Builders:

Replace electrical cords
Replace batteries
Replace fuse(s)
Replace switches and other sensors
Replace plugs and sockets
Replace control panel components (e.g., relays, motor starters)
Replace AC motors (e.g., 3 phase, single phase)
Replace DC motors

Competency: Interpret electrical/electronic drawings

Competency Builders:

Interpret basic electric/electronic standards and symbols (e.g., NEC, IEC)
Interpret schematic drawings
Interpret cable drawings
Interpret component drawings
Interpret logic diagrams
Interpret control panel drawings
Interpret connection drawings
Interpret interconnection drawings
Interpret printed circuit board drawings
Interpret harness drawings
Interpret package drawings
Interpret mechanical/electronic production blueprints and assembly drawings

Competency: **Demonstrate proficiency in direct current (DC) circuits**

Competency Builders:

Describe voltage, current, resistance, power, and energy
Solve algebraic problems to include exponential (prerequisite to DC)
Measure properties of a circuit using volt-ohm meter (VOM) and digital volt-ohm meter (DVM) meters and oscilloscopes
Apply Ohm's Law
Construct parallel circuits
Construct series circuits
Construct series parallel and bridge circuits
Define voltage divider circuits (loaded and unloaded)
Construct DC circuits that demonstrate the maximum power transfer theory
Solve problems in electrical units utilizing metric units
Describe the principles and operation of electrochemical supplies
Apply Kirchoff's law
Interpret color codes and symbols to identify electrical components and values
Measure properties of a circuit using analog and digital meters and oscilloscopes
Measure conductance and resistance of conductors and insulators
Describe magnetic properties of circuits and devices
Describe the physical and electrical characteristics of capacitors and inductors
Describe RC and RL time constants
Set up power supplies for DC circuits
Operate power supplies for DC circuits
Analyze frequency spectrums
Apply Thevenin's and Norton's theorems

Competency: **Demonstrate proficiency in alternating current (AC) circuits**

Competency Builders:

Solve basic trigonometric problems as applicable to electricity (prerequisite to AC)
Analyze AC signals utilizing VOM, DVM, oscilloscope, frequency counter and function generator
Analyze power in AC circuits
Measure power in AC circuits
Operate capacitor and inductor analyzers for AC circuits
Analyze properties of an AC signal
Describe the principles and operation of the characteristics of sinusoidal and non-sinusoidal wave forms
Identify AC sources
Describe the principles and operation of the characteristics of capacitive circuits
Demonstrate the operation of capacitive circuits
Describe the principles and operation of the characteristics of inductive circuits
Demonstrate the operation of inductive circuits
Describe the principles and operation of the principles of transformers
Demonstrate the operation of AC circuits utilizing transformers
Operate differentiators and integrators to determine RC and RL time constants
Describe the principles and operation of the characteristics of RLC circuits (series, parallel, and complex)
Demonstrate the operation of RLC circuits (series, parallel, and complex)
Describe the principles and operation of the characteristics of series and parallel resonant circuits
Operate series and parallel resonant circuits
Describe the principles and operation of the characteristics of frequency selective filter circuits
Demonstrate the operation of frequency selective filter circuits
Operate polyphase circuits
Describe basic motor theory and operation
Describe basic generator theory and operation
Operate power supplies for AC circuits
Describe the principles and operation of various power conditioning (e.g., isolation transformers, surge suppressors, uninterruptable power systems)
Describe the principles and operation of various safety grounding systems (e.g., lightning arresters, ground fault interrupters, etc.)
Apply maximum power transfer theorems
Apply Thevenin's and Norton's theorems to analyze AC networks

Unit: Drafting Technology

Competency: Apply basic drafting skills

Competency Builders:

Use drafting equipment, measuring scales, drawing media, drafting instruments and consumable materials, blueprint machine
Identify line styles, weights (alphabet of lines)
Select proper drawing scale, introduction to different types
Prepare title blocks and other drafting formats
Apply freehand and other lettering techniques
Prepare multi-view drawings
Prepare multi-view sketches
Prepare orthographic views
Prepare change control block
Describe change control block/revision block
Measure angles
Draw horizontal, vertical, angular, parallel, and perpendicular lines
Transfer an angle
Construct tangent lines (to arcs) and tangent arcs (to arcs)
Bisect angles and arcs
Bisect lines
Divide lines
Construct three-point circle
Construct regular hexagon, pentagon, and octagon
Reproduce a drawing
Prepare single-view drawings
Prepare dimension drawings
Interpret notes and dimensions to determine part
Draw arcs, circles, and conics
Transfer measurements

Competency: Apply intermediate drafting skills

Competency Builders:

Describe types of blueprints and their applications
Apply isometric, oblique and perspective sketching techniques
Prepare isometric, oblique and perspective sketches
Prepare sectional views
Prepare auxiliary views
Identify ANSI symbols
Prepare views of drilled and tapped holes, counterbores, countersinks
Apply systems drafting techniques
Identify a bill of materials
Dimension drawings using ANSIy14.5 standards
Describe purpose of auxiliary and sectional views

Competency: Apply advanced drafting skills

Competency Builders:

Interpret reports and specifications
Prepare pictorial drawings
Prepare schematics
Draw conics
Interpret basic pneumatic/hydraulic standard and symbols
Interpret various drawings (e.g., welding, casting, stamping, forging, civil, maps, pattern shop)

Competency: Interpret basic prints

Competency Builders:

Visualize object from drawing
Interpret orthographic projections
Interpret isometric views
Interpret sectional views
Interpret detail and assembly drawings
Interpret dimensions
Interpret tolerances

Competency: Interpret intermediate prints

Competency Builders:

Interpret screw thread specifications
Identify structural steel shapes
Interpret special symbols
Interpret electrical, pneumatic/hydraulic drawings
Interpret schematics

Competency: Interpret advanced prints

Competency Builders:

Interpret GD&T characteristic symbols
Interpret GD&T supplementary symbols

Competency: **Demonstrate knowledge of basic geometric dimensioning and tolerancing**

Competency Builders:

Identify geometric characteristics and symbols (i.e., flatness, straightness, roundness, cylindricity, profile of line, profile of surface, perpendicularly, angularity, parallelism, circular, runout, total indicated runout, position, concentricity, and symmetry)
Define maximum material condition
Define least material condition
Define regardless of feature size condition
Describe feature control blocks
Describe datum surfaces and targets
Define flatness (pitch)
Define straightness (yaw)
Define roundness
Define cylindrically
Define profile of line
Define profile of surface
Define perpendicularity
Define angularity
Define parallelism
Define circular runout
Define total runout
Define true position concept to determine tolerance for location of holes in mating parts

Competency: **Convert dimensions and tolerances**

Competency Builders:

Convert dimensions and tolerances from English units to metric units
Convert dimensions and tolerances from metric units to English units

Competency: Apply revision control process

Competency Builders:

Apply drawing balloons
Apply documentation (including project filing, back-up material, tracking process)
Apply change control block
Apply revision levels

Competency: Demonstrate dimensioning techniques

Competency Builders:

Construct arrowheads using various styles/disciplines
Apply symbols for surface and texture control
Add labels/notes to drawing
Interpret decimal tolerance dimensions
Dimension arcs
Dimension angles
Dimension curves
Dimension rounded-end shapes
Dimension spherical objects
Dimension cylindrical objects
Dimension cones, pyramids, and prisms
Dimension features on circular center line
Dimension theoretical point of intersection
Dimension object using rectangular coordinate system
Dimension object using polar coordinate system
Dimension object using tabular coordinate system
Dimension object using ordinate dimensioning system

Competency: Apply geometric dimensioning and tolerancing

Competency Builders:

Interpret decimal tolerance dimensions
Calculate clearance fit tolerances of mating parts
Dimension clearance fit tolerances of mating parts
Calculate interference fit tolerances of mating parts
Dimension interference fit tolerances of mating parts
Calculate tolerances to mating parts using standard fit tables
Assign tolerances to mating parts using standard fit tables
Apply positional and form tolerancing symbols
Apply symbols for true position
Apply symbols for maximum material control and regardless of feature size
Calculate effects of dimensional stack-up
Calculate transitional fit tolerances
Dimension transitional fit tolerances

Competency: Perform basic physical layouts

Competency Builders:

Use inside diameter (ID), outside diameter (OD), and hermaphrodite calipers
Layout with combination square
Layout with scriber, divider and trammel
Use surface plate
Use surface gage
Use layout fluid
Use V-blocks
Use clamps
Use angle plate
Use parallels
Use punches
Use transfer method tools
Use layout hammer
Use machinist's square
Use universal bevel protractor
Use machinist's scale

Competency: Prepare mechanical drawings

Competency Builders:

Interpret basic mechanical standards and symbols
Prepare assembly drawings
Prepare welding drawings
Prepare bearing drawings
Prepare casting drawings
Prepare forging drawings
Prepare tool drawings
Prepare molding diagrams
Prepare drawings with special processed holes
Prepare stamping drawings
Prepare numerical control drawings/instructions
Prepare installation drawings
Prepare purchase part drawings
Prepare approval drawings

Competency: Prepare advanced mechanical drawings

Competency Builders:

Resolve problems by descriptive geometry and revolutions
Use precision dimensioning to include geometric characters
Use precision measuring instruments (e.g., calipers)
Prepare fastener drawings
Prepare cam drawings
Prepare gear drawings
Prepare spring drawings
Prepare pulley and chain drive drawings

Unit: CADD Fundamentals

Competency: Demonstrate basic use of computer operating system

Competency Builders:

Create ASCII text files with a text editor
Explain rules for naming files and directories
Manage files
Create directories
Remove directories
Change directories
Copy files
Rename files
Erase files
Format diskettes
Label diskettes
Explain the syntax of operating system commands
Use wildcards in operating system commands

Competency: Operate a CADD system

Competency Builders:

Execute CADD system
Use keyboard input
Use screen and tablet menus
Use other input devices (e.g., scanner, digitizer)
Create scaled plots
Operate a pen plotter
Operate a printer-plotter (i.e., laser plotter)
Access on-line help for commands
Use file conversion
Use data transfer

Competency: Select entities for action

Competency Builders:

Add or remove entities separately
Add or remove entities using a window
Add or remove entities with a crossing-box
Select entities using a fence
Select entities by other methods (e.g., last, previous, type, all, etc.)

Competency: Create 2-D orthographic drawings

Competency Builders:

Create primitive drawing entities
Draw utilizing absolute Cartesian coordinates
Draw utilizing relative Cartesian coordinates
Draw utilizing polar coordinates
Draw using construction aides (e.g., snaps, grid, snap, etc.)
Change drawing attributes
Edit drawing entity properties (e.g., color, layer, thickness, linetype)
Construct drawing entities (e.g., offset, timer, extend, break, mirror, etc.)
Edit drawing entities (e.g., offset, trim, extend, break, mirror, etc.)
Set system variables (e.g., units, scale)
Use system variables
Create layers
Name layers
Manipulate layers
Save files
Create back-ups
Create hatches, patterns, symbols
Recall drawing templates/blocks

Competency: Annotate orthographic drawings

Competency Builders:

Create text styles
Edit text styles
Select text styles
Apply notes

Competency: Dimension orthographic drawings

Competency Builders:

Create dimensions
Edit text
Control dimension variables/models

Competency: Control display

Competency Builders:

Apply view control while drawing (e.g., zoom and pan)
Control view resolution (e.g., viewers)
Save views
Display views

Competency: Extract entity and drawing information

Competency Builders:

Measure distances
Measure areas
Identify locations
List entity characteristics (e.g., length, size, location, properties, etc.)

Unit: Equipment Installation

Competency: Explain installation procedures

Competency Builders:

Explain relocation procedures for new equipment in an existing facility
Explain the use of anchors and isolators
Explain procedures for moving and installing new equipment
Explain leveling and aligning procedures
Explain test run guidelines
Explain safety precautions for equipment installation procedures
Explain grounding procedures
Explain installation of utilities (e.g., electricity, air, water, drains)

Competency: Prepare for equipment installation

Competency Builders:

Identify equipment requirements (including safety)
Identify maintenance services needed
Identify method of moving and equipment needed
Identify measuring devices
Calculate weights
Follow manufacturer's specifications and mannuals
Identify applicable electrical, mechanical, hydraulic, and/or pneumatic principles
Read drawings/schematics
Revise drawings if applicable
Interpret prints

Competency: Install Equipment

Competency Builders:

Prepare site
Use measuring devices
Calculate weight
Follow manufacturer's specifications
Use appropriate moving equipment
Align equipment to layout specifications
Apply electrical, mechanical, hydraulic, and/or pneumatic principles

Competency: Explain rigging functions

Competency Builders:

Estimate the weight of a load
Find the center of gravity
Identify the rigging and slings used in maintenance work
Explain safety inspection procedures for rigging, ropes, and slings
Perform safety inspection procedures for rigging, ropes, and slings
Identify rope fiber types
Tie rigging knots, bends, and hitches
Identify types of wire rope
Cut wire rope assemblies and termination's
Identify cranes and hoists
Identify and explain scaffolding types
Identify safety equipment (e.g., life belts, nets, etc.)

Competency: Perform rigging functions

Competency Builders:

Perform safety inspection procedures for rigging, ropes, and slings
Tie rigging knots, bends, and hitches
Cut wire rope
Seize wire rope
Install wire rope eyes, sockets, and hooks
Splice wire rope
Erect a scaffold
Rig life belts and nets

Unit: Hydraulics and Pneumatics

Competency: Describe fluid flow concepts

Competency Builders:

Explain Pascal's Law
Explain Boyle's Law
Explain Bernoulli's Principle
Describe flow velocity
Explain how heat and pressure relate to power and transmission
Describe physical and chemical properties of a fluid
Describe fluids in motion in closed conductors
Describe continuity of mass flow
Identify types of fluids
Identify properties of fluids
Identify English and metric units of measurement for pressure, density, and viscosity

Competency: Describe energy considerations

Competency Builders:

Differentiate work and power
Differentiate potential and kinetic energy
Explain energy conservation concept
Explain hydraulic horsepower
Explain work of compression in compressible fluids

Competency: Describe system losses

Competency Builders:

Differentiate turbulent and laminar flow
Explain friction factor
Explain pressure losses
Identify potential system losses (e.g., leaks, wear, component sizing, heat, dirt)

Competency: Describe hydrostatics

Competency Builders:

Explain pressure, density, and viscosity
Explain buoyancy
Explain equilibrium

Competency: Calculate energy

Competency Builders:

Apply Pascal's Law
Apply Bernoulli's Principle
Apply Boyle's Law
Calculate work and power
Calculate potential and kinetic energy
Calculate hydraulic horsepower
Calculate flow velocity and pressure
Calculate pressure losses
Calculate laminar flow
Calculate pump capacity
Calculate system requirements

Competency: Design basic hydraulic/pneumatic system

Competency Builders:

Use common symbols
Create circuit diagrams (i.e., schematics)
Diagram closed-loop hydraulic system
Diagram an air supply system

Competency: Describe component operation

Competency Builders:

Identify functions and operation of hydraulic components
Identify functions and operation of pneumatic components
Explain application(s) of different materials (e.g., plastic, copper)

Competency: Interpret hydraulic and pneumatic schematics

Competency Builders:

Identify common symbols
Sketch circuit diagrams (i.e., schematics)
Interpret circuit diagrams (i.e. schematics)
Sketch circuit analysis
Diagram an air supply system

Competency: Troubleshoot hydraulic and pneumatic circuits

Competency Builders:

Analyze hydraulic circuits
Troubleshoot hydraulic circuits
Analyze pneumatic circuits
Troubleshoot pneumatic circuits

Competency: Perform pump maintenance and repair

Competency Builders:

Identify types and operating features of pumps
Identify pump capacity and system requirements
Explain packing and seal requirements
Explain operating principles of pumps (e.g., centrifugal, propeller and turbine rotary, metering)
Perform pump maintenance
Disassemble a pump
Reassemble a pump

Competency: **Maintain piping and accessories for high and low pressure fluid power systems**

Competency Builders:

Identify components of a piping system
Explain maintenance features of both metallic and non-metallic piping systems
Explain types of values and their operation and maintenance
Explain use and maintenance of strainers, filters, and traps in piping systems
Join common fittings
Join metallic pipe
Join plastic pipe
Join copper and steel tubing
Bend copper and steel tubing
Cut copper and steel tubing
Flare tubing

Competency: **Maintain hydraulic system components**

Competency Builders:

Install a contaminant removal system
Maintain a contaminant removal system
Explain operation and use of heat exchanges
Identify reservoir requirements
Compute hose requirements
Install hydraulic lines
Select control valves and servo-type valves
Install control valves and servo-type valves

Competency: Troubleshoot hydraulic systems

Competency Builders:

Interpret hydraulic schematic
Identify causes of failure modes
Connect electrically controlled valves
Explain hydraulic system troubleshooting techniques
Repair or replace hydraulic valves
Repair or replace hydraulic cylinders
Repair or replace hydraulic pumps and motors
Install hydraulic components

Competency: Describe reciprocating and rotary air compressors

Competency Builders:

Explain relationship of force, weight, mass, and density in pneumatic system
Explain operation of reciprocating compressors
Explain operation of rotary compressors
Explain primary and secondary air treatment (e.g., air dryers, lubricating systems)
Explain operation of compressor valves, cylinders, and motors

Competency: Maintain pneumatic systems

Competency Builders:

Install pneumatic system components
Explain pneumatic system maintenance techniques
Explain pneumatic system troubleshooting procedures
Isolate faults in air compressors
Repair or replace air compressors
Isolate faults in control valves
Repair or replace control valves
Isolate faults in air motors
Repair or replace air motors
Isolate faults in air dryers
Repair or replace air dryers
Maintain proportioning and servo valves

Competency: Troubleshoot pneumatic systems

Competency Builders:

Interpret pneumatic schematic
Diagram an air supply system
Install pneumatic system components
Explain pneumatic system troubleshooting procedures
Troubleshoot air compressors
Troubleshoot pneumatic control valves
Troubleshoot air motors
Troubleshoot air dryers

Competency: Maintain vacuum systems

Competency Builders:

Describe characteristics associated with vacuum systems and sub atmospheric pressure
Describe the principles and operation of vacuum gauges
Demonstrate use of vacuum gauges
Repair or replace vacuum gauges
Describe the principles and operation of vacuum pumps
Demonstrate use of vacuum pumps
Repair or replace vacuum pumps
Describe the principles and operation of vacuum controls
Demonstrate use of vacuum controls
Repair or replace vacuum controls

Unit: Industrial Manufacturing Technology

Competency: Describe industrial manufacturing process

Competency Builders:

Demonstrate use and maintenance of personal protective equipment
Explain techniques of measuring motion, forces, voltage, current, power, distance, time and temperature
Explain mechanical and chemical properties of ferrous and non-ferrous metals
Explain industrial manufacturing process
Explain industrial use of non-metallic solids (e.g., ceramics, polymers), liquids, and gases
Develop flow chart and process sheets
Draft preventive maintenance and calibration procedures
Explain need for manufacturing documentation (e.g., ISO 9000)
Define quality process

Competency: Demonstrate knowledge of materials requirements planning

Competency Builders:

Define materials requirements planning
Explain importance of maintaining and controlling inventory (e.g., quantity, price, quality, minimal lot sizes, and timeliness)
Define master production schedule and bill of materials
Explain inventory carrying cost and economic order quantity
Describe the use of the computer in MRP
Calculate net requirements

Competency: Demonstrate knowledge of supply materials

Competency Builders:

Describe role of purchase requisitions
Describe role of material specifications
Describe role of quality parameters
Define supplier certification rating methods
Describe role of source inspector
Describe role of receiving

Competency: Demonstrate knowledge of plant layouts

Competency Builders:

Describe the importance of flexibility
Differentiate among product layout, process layout, fixed position layout, and cellular layout
Describe the type of production suited to each layout
Describe advantages and disadvantages of each layout

Competency: Demonstrate knowledge of material flow

Competency Builders:

Describe importance of flexibility
Differentiate straight-line, U-shaped, S-shaped, convoluted and comb patterns
Describe advantages and disadvantages of each pattern

Competency: Maintain quality control of materials handling

Competency Builders:

Maintain system for physical handling and movement of material in-process and in-storage
Monitor system of physical handling and movement of material in-process and in-storage
Maintain system for physical handling and movement of finished products
Monitor system of physical handling and movement of finished products
Write requests for deviation from specifications
Implement quality control and inspection standards and procedures
Write engineering change notices and rejection reports
Monitor reports of discrepancy or rejects during production process
Conduct quality tests under different environmental conditions

Competency: Demonstrate knowledge of post-production control

Competency Builders:

Explain importance of product protection, identification and storage
Describe methods of identifying products (e.g., labels, bar codes, radio frequency systems and magnetic strip systems)
Describe manual methods of storage and retrieval
Describe automated storage and retrieval systems (ASRS)
Describe automated guided vehicle moving systems (AGVS)

Competency: Analyze a manufacturing project

Competency Builders:

Explain the "how" of project selection
Explain the "how" of project implementation
Explain the "how" of project evaluation
Explain the "how" of planning continuing improvement
Explain the "how" of planning predictive maintenance

TECH PREP

"GET SERIOUS . . . ABOUT SUCCESS"

Electromechanical Technician

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—NOTICE—

Each Tech-Prep Competency Profile developed should respond to the labor market demands of your Tech Prep Consortium. Therefore, the following pages should be examined carefully before being selected for use in TCP Part I. **[See "The TCP Process" for more information.]** For example, in some cases the number of units far exceeds the amount of content that can be covered within a 4 + 2 TPAD Program. All the units listed in this section will not necessarily apply to your situation, nor will all the competencies within each unit be appropriate. Note that several units appear within each specific occupation and would need to only appear once if you are compiling a cluster of occupations. **[See "TCP Matrix" and "How to Use the TCP Binder" for more information.]**

Unit: Communications Literacy

NOTE: This content was extracted from the 9-12 cluster of Ohio's Model Language Arts Program. Due to statewide initiatives other than Tech Prep, this literacy unit was not altered to meet competency-based criteria. Each literacy unit forms a critical link between academic teachers and members of business, industry, and labor. [See "The TCP Process" for more information.]

Subunit: Reading—Structure

Competencies:

RS1	Exhibit knowledge of language structure
RS2	Recognize that there may be more than one interpretation of reading selections
RS3	Recognize various literary devices
RS4	Recognize and discuss literary elements
RS5	Develop and use an increasingly sophisticated vocabulary gained through context
RS6	Apply knowledge of language structure to reading
RS7	Explain why there may be more than one interpretation of reading selections
RS8	Recognize effect of literacy devices on meaning
RS9	Analyze author's use of literary elements
RS10	Recognize relationship of structure to meaning
RS11	Describe various interpretations and meaning levels in reading selections
RS12	Characterize author's use of literary devices
RS13	Characterize use of literary techniques
RS14	Critique a variety of literature with regard to plot, dialogue, theme, setting, and characterization
RS15	Apply an expanding vocabulary gained through reading
RS16	Explain various interpretations and meaning levels in reading selections
RS17	Analyze use of literary techniques (e.g., extended metaphor, simile, personification, hyperbole, pun, alliteration)
RS18	Understand use of literary devices (e.g., irony, satire, allegory, onomatopoeia)
RS19	Analyze and synthesize pieces of literature with regard to plot, dialogue, theme, setting, and characterization

Subunit: Reading—Meaning Construction

Competencies:

RM1	Demonstrate ability to recognize appropriate pre-reading strategies
RM2	Describe effectiveness of a reading selection
RM3	Read to clarify personal thinking and knowledge
RM4	Support interpretation of text by locating and citing specific information
RM5	Develop personal response to a variety of literary works
RM6	Recognize diverse literary interpretations
RM7	Engage in self-selected reading activities
RM8	Confirm and extend meaning in reading by researching new concepts and facts
RM9	Self-monitor and apply corrective strategies when communication has been interrupted or lost
RM10	Use features of literary genres to extend meaning
RM11	Assess effectiveness of a selection read
RM12	Use reading as a possible problem-solving strategy to clarify personal thinking and knowledge
RM13	Use knowledge of semantic elements (e.g., figurative language, denotation, connotation, dialect) to clarify meaning when reading
RM14	Predict, recognize, interpret, and analyze themes based on familiarity with author's work
RM15	Compare and contrast literary genres
RM16	Assess validity and quality of selection read
RM17	Clarify meaning when reading
RM18	Compare personal reaction to critical assessment of a literary selection
RM19	Assess validity of diverse literary interpretations
RM20	Use reference books to find, evaluate, and synthesize information
RM21	Identify tone of a literary work
RM22	Critique validity of diverse literary interpretations
RM23	Integrate personal reaction to and critical assessment of a literary selection

Subunit: Reading—Application

Competencies:

RA1 Select and read material for personal enjoyment and information
RA2 Read a variety of complete, unabridged works
RA3 Employ various reading strategies according to purpose
RA4 Participate in selection of books, materials, and topics for literature study groups
RA5 Develop and apply knowledge of the interrelationship of concepts
RA6 Read selections from a variety of styles and formats, recognizing that style and format influence meaning
RA7 Extend value of reading, writing, speaking, viewing, and listening by pursuing, through reading, new concepts and interests developed as a result of these activities
RA8 Read extensively from a particular author's work and explain elements of author's style

Subunit: Reading—Multidisciplinary

Competencies:

RM1 Connect themes and ideas across disciplines through literature
RM2 Read to facilitate learning across curriculum
RM3 Read to develop awareness of human rights and freedom
RM4 Participate actively in a community of learners
RM5 Recognize and explain interaction between literature and various cultural domains (e.g., social technological, political, economic)
RM6 Explore and analyze a variety of cultural elements, attitudes, beliefs, and value structures by men and women of many racial, ethnic, and cultural groups
RM7 Value thinking and language of others
RM8 Relate literature to historical period about which or in which it was written
RM9 Read to facilitate content learning

Subunit: Writing—Structure
Competencies:

WS1 Develop and expand a repertoire of organizational strategies (e.g., narration, comparison/contrast, and description) through a practice and discussion
WS2 Clarify word choice according to audience, topic, and purpose
WS3 Locate and correct errors in usage, spelling, and mechanics using a variety of resources
WS4 Recognize information gained from primary and secondary sources
WS5 Develop writing which contains ordered, related, well-developed paragraphs with sentences of varied lengths and patterns
WS6 Use information from a variety of sources to develop an integrated piece of writing
WS7 Evaluate and revise writing to focus on such things as audience, tone, and purpose
WS8 Recognize differences between documentation and reference list styles
WS9 Develop extended pieces of writing which contain ordered, related, well-developed paragraphs with sentences of varied lengths and patterns
WS10 Select from a repertoire of organization strategies a pattern appropriate to a topic
WS11 Synthesize information from a variety of sources
WS12 Refine word choice and tone according to audience, situation, and purpose
WS13 Appropriately cite information gained from primary and secondary sources
WS14 Use style manuals or software to prepare documentation and reference lists
WS15 Develop effectively organized pieces of expository writing containing strong voice, clear thesis, and well-developed ideas
WS16 Identify organization patterns appropriate to writing topic
WS17 Respond to others' suggested revisions to a writing piece

Subunit: Writing—Meaning Construction

Competencies:

WM1 Demonstrate knowledge of the recursive nature of the writing process by applying it appropriately to various topics, situations, and audiences

WM2 Develop criteria for writing evaluation using scoring guides and peer/teacher assistance to clarify meaning

WM3 Respond to others' suggested revisions to a piece of writing

WM4 Use word processing, graphics, and publishing aids to construct meaning in writing

WM5 Engage in self-initiated writing activities

WM6 Incorporate personal criteria with generally accepted standards for writing evaluation

WM7 Evaluate, analyze, and synthesize information for writing

WM8 Evaluate own writing using personal and established scoring criteria

WM9 Assess personal/peer revisions to a writing piece

WM10 Recognize and refine personal writing styles

Subunit: Writing—Application
Competencies:

WA1	Apply appropriate writing techniques suitable for varied writing tasks
WA2	Use sentence-combining techniques to improve syntactic fluency and maturity
WA3	Write in response to prompted and self-selected topics in practical, persuasive, descriptive, narrative, and expository domains
WA4	Develop personal voice in writing
WA5	Consider audience and purpose for writing
WA6	Develop criteria for selection and potential development of topic
WA7	Write in a journal or learning log to clarify personal thinking and knowledge
WA8	Apply an expanding vocabulary gained through writing
WA9	Make judicious use of reference sources (e.g., dictionary, thesaurus, on-lien data base, encyclopedia)
WA10	Demonstrate, an appreciation for aesthetically pleasing language through word choice and style
WA11	Apply revising and editing strategies needed for writing task
WA12	Vary sentence lengths and patterns
WA13	Refine personal voice in writing
WA14	Vary styles and formats for intended purpose and audience
WA15	Apply criteria for selection and development of topic
WA16	Participate in peer review of writing in progress
WA17	Use transitions between sentences, ideas, and paragraphs in writing
WA18	Revise and edit papers extensively in preparation for presentation/publication
WA19	Develop a variety of genres
WA20	Focus writing and tone on such elements as audience, situation, and purpose
WA21	Develop topic fully and appropriately
WA22	Use writing process to clarify personal thinking and knowledge
WA23	Apply appropriate recursive writing process as suggested by writing task and writer's process
WA24	Develop an extended piece of writing
WA25	Revise writing and tone to assure focus on such elements as audience, situation, and purpose
WA26	Use writing process to write reflectively

Subunit: Writing—Multidisciplinary
Competencies:

WM1	Use writing process for learning across curriculum
WM2	Use writing process to demonstrate knowledge of need for human rights and freedom
WM3	Value and apply collaborative skills in writing process
WM4	Write in response to reading, speaking, viewing, and listening
WM5	Use multidisciplinary resources in writing projects
WM6	Use writing process to facilitate learning across curriculum
WM7	Recognize value of and engage in collaboration in writing process
WM8	Use communication processes to develop a published writing piece in collaboration with others
WM9	Record experiences and observations related to content learning
WM10	Apply collaborative skills in writing process
WM11	Write collaboratively with peers
WM12	Use cross-disciplinary resources in writing projects

Subunit: Listening/Visual Literacy—Structure
Competencies:

LS1	Listen to and view a wide variety of genres
LS2	Become aware of an author's style through listening and viewing a variety of works
LS3	Recognize correct and appropriate grammar, diction, and syntax
LS4	Expand vocabulary through listening to and viewing varied media
LS5	Recognize beauty of language
LS6	Enhance recognition of an author's style through listening and viewing a variety of works
LS7	Recognize use and misuse of language in media
LS8	Refine knowledge of style through listening and viewing multiple works by the same author
LS9	Expand and refine grammar, diction, and syntax through listening
LS10	Compare authors' styles through viewing and listening to their works
LS11	Expand knowledge of complex grammar, diction, and syntax issues

Subunit: Listening/Visual Literacy—Meaning Construction Competencies:

LM1 Develop critical thinking skills necessary to evaluate media and assess oral presentations
LM2 Compare new oral texts to past experiences and knowledge in order to enhance comprehension
LM3 Recognize how rhythmic patterns, silence, and cadences enhance quality of speech and literature
LM4 Focus listening and viewing on themes and/or plots
LM5 Gather information from listening and viewing experiences to enhance research
LM6 Use critical thinking skills to evaluate media and oral presentations
LM7 Use prior knowledge and experiences to facilitate comprehension of new oral texts
LM8 Identify rhythmic and time patterns in speech and literature
LM9 Identify and analyze themes and/or plots when listening and viewing
LM10 Use information gathered from listening and viewing experiences to expand research
LM11 Enhance use of critical thinking skills to evaluate media and oral presentations
LM12 Consider prior knowledge and experiences when attempting to understand the meaning of new texts
LM13 Appreciate rhythmic and time patterns of speech and literature
LM14 Select viewing and listening materials to support written text
LM15 Evaluate media and oral presentations analytically and critically
LM16 Organize prior knowledge and experiences to comprehend new texts
LM17 Organize and use viewing and listening materials to support written text

Subunit: Listening/Visual Literacy—Application Competencies:

LA1 Listen attentively during oral reading
LA2 Use media as stimuli for learning and thinking
LA3 Develop knowledge of structure through art, music, and literature
LA4 Use electronic media to enhance and highlight language learning
LA5 Listen and view for entertainment and enjoyment
LA6 Use technology and other media as means of expressing ideas

Subunit: Listening/Visual Literacy—Multidisciplinary Competencies:

LM1	Facilitate learning across curriculum through critical listening and viewing
LM2	Engage in individual, small-group, and whole-group listening and viewing activities
LM3	Develop language arts (e.g., viewing, listening) projects collaboratively
LM4	Investigate language and cultural differences through listening and viewing activities
LM5	Participate in a community of learners through productive listening

Subunit: Oral Communication—Structure Competencies:

OS1	Refine oral communication skills
OS2	Demonstrate knowledge of grammar, usage, and syntax when presenting
OS3	Select topics and vocabulary suitable to audience
OS4	Organize notes and ideas for speaking
OS5	Use language imaginatively
OS6	Modulate voice to meaning when interpreting literature orally
OS7	Organize notes and ideas for formal, semiformal and informal presentations of information
OS8	Refine speaking techniques for formal, semiformal, and informal settings
OS9	Develop repertoire of organizational strategies for presenting information orally
OS10	Expand vocabulary to fit topic
OS11	Select topics suitable to audience, situation, and purpose
OS12	Select appropriate strategies when organizing notes and ideas for speaking

Subunit: Oral Communications—Meaning Construction
Competencies:

OM1	Make connections between prior knowledge and new information for oral presentations
OM2	Participate in informal speaking activities
OM3	Use interviewing techniques to gather information
OM4	Communicate orally to entertain and to inform
OM5	Participate in group communication activities
OM6	Take and organize notes when preparing speech/presentation
OM7	Interpret texts orally to illustrate meaning
OM8	Respond to needs of various audiences
OM9	Gather and assess information for speaking
OM10	Communicate orally to inform and persuade
OM11	Prepare and deliver formal speech/presentation
OM12	Participate in a variety of oral interpretations
OM13	Assess needs of audience and adjust language and presentation according to their knowledge
OM14	Analyze and synthesize information for speaking
OM15	Describe effectiveness of literary selection
OM16	Describe topic or idea in order to clarify personal/audience thinking
OM17	Analyze and synthesize information gathered from a variety of sources for speaking
OM18	Describe validity and/or quality of a literary selection and justify selection
OM19	Interpret orally a variety of literature
OM20	Describe topic or idea to clarify meaning for others

Subunit: Oral Communication—Application
Competencies:

OA1	Become proficient at using interviewing techniques
OA2	Give an oral interpretation for a specific audience
OA3	Develop and apply oral communication skills for cooperative/collaborative learning
OA4	Use oral communication for a variety of purposes and audiences (e.g., negotiations, book reviews, rationales)
OA5	Develop and apply decision-making strategies
OA6	Practice interviewing techniques
OA7	Apply interviewing techniques to purposeful interviews
OA8	Focus oral interpretation on a specific audience

Subunit: Oral Communications—Multidisciplinary Competencies:

OM1	Value thinking and language of others
OM2	Develop oral projects collaboratively
OM3	Be involved in individual, small-group, and whole-group language activities
OM4	Participate actively in a community of learners
OM5	Investigate language and cultural differences through oral language activities

Unit: Mathematics Literacy

NOTE: This content was extracted from the 9-12 cluster of Ohio's Model Mathematics Program. Due to statewide initiatives other than Tech Prep, this literacy unit was not altered to meet competency-based criteria. Each literacy unit forms a critical link between academic teachers and members of business, industry, and labor. [See "The TCP Process" for more information.]

Subunit: Numbers and Number Relations
Competencies:

NR1 Compare, order, and determine equivalence of real numbers
NR2 Estimate answers, compute, and solve problems involving real numbers
NR3 Compare and contrast real number system, rational number system, and whole number system
NR4 Extend knowledge to complex number system and develop facility with its operation

Subunit: Measurement
Competencies:

M1 Estimate and use measurements
M2 Understand need for measurement and probability that any measurement is accurate to some designated specification
M3 Understand and apply measurements related to power and work
M4 Understand and apply measurement concepts of distance-rate-time problems and acceleration problems
M5 Use real experiments to investigate elasticity, heat, sound, electricity, magnetism, light, acceleration, velocity, energy, and gravity
M6 Use real-world problem situations involving mass and weight
M7 Use real-world problem situations involving simple harmonic motion
M8 Establish ratios with and without common units
M9 Construct and interpret maps, tables, charts, and graphs as they relate to real-world mathematics
M10 Understand and solve rate-change problems
M11 Understand and solve right triangle relationships as they relate to measurement, specifically to Pythagorean theorem
M12 Graph and interpret ordered pairs
M13 Compute total sales from a variety of items
M14 Comprehend and compute rates of growth or decay
M15 Comprehend, compute, and interpret real problems involving annuities

Subunit: Measurement (continued)

Competencies:

M16 Develop an ability to identify real problems and provide possible solutions
M17 Express and apply different types of measurement scales
M18 Identify area and volume

Subunit: Estimation and Mental Computation

Competencies:

E1 Use estimation to eliminate choices in multiple-choice tests
E2 Use estimation to determine reasonableness of problem situations in a wide variety of applications
E3 Estimate shape of graphs of various functions and algebraic expressions
E4 Use mental computation when computer and calculator are inappropriate

Subunit: Data Analysis and Probability

Competencies:

D1 Organize data into tables, charts, and graphs
D2 Understand and apply measures of central tendency, variability, and correlation
D3 Use curve fitting to predict from data
D4 Use experimental or theoretical probability, as appropriate, to represent and solve problems involving uncertainty
D5 Use computer simulations and random number generators to estimate probabilities
D6 Test hypotheses using appropriate statistics
D7 Read, interpret, and use tables, charts, and graphs to identify patterns, note trends, draw conclusions, and make predictions
D8 Identify probabilities of events involving unbiased objects
D9 Use sampling and recognize its role in statistical claims
D10 Design a statistical experiment to study problem, conduct experiment, and interpret and communicate outcomes
D11 Describe normal curve in general terms and use its properties
D12 Create and interpret discrete probability distributions
D13 Understand concept of random variable
D14 Apply concept of random variable to generate and interpret probability distributions, including binomial, uniform, and chi square

Subunit: Algebra
Competencies:

A1 Describe problem situations by using and relating numerical, symbolic, and graphical representations
A2 Use language and notation of functions in symbolic and graphing settings
A3 Recognize and use equivalent zeros of a function, roots and the solution of an equation in terms of graphical and symbolic representations
A4 Describe and use logic of equivalence in working with equations, inequalities, and functions
A5 Develop graphical techniques of solution for problem situations involving functions
A6 Explore and describe characterizing features of functions
A7 Make arguments and proofs in algebraic settings
A8 Factor difference of two squares
A9 Identify slope, midpoint, and distance
A10 Explore and combine rational functions
A11 Explore factoring techniques
A12 Solve quadratic equations by factoring and formula
A13 Set up and solve linear equations
A14 Solve systems of linear equations with two variables
A15 Describe geometric situations and phenomena using variables, equations, and functions
A16 Describe measures of central tendency, mean, median, mode, and variance algebraically and graphically
A17 Represent inequalities on number line and in coordinate plane
A18 Use coordinate arguments in making geometric proofs
A19 Symbolize transformations of figures and graphs
A20 Explore geometric basis for functions of trigonometry
A21 Graph linear functions
A22 Develop and use vectors to represent direction and magnitude including operations
A23 Use polar and parametric equations to describe, graph, and solve problem situations
A24 Represent sequences and series as functions both algebraically and graphically
A25 Explore recursive functions and procedures using spreadsheets, other computer utilities, and appropriate notions
A26 Describe and solve algebraic situations with matrices
A27 Describe and use inverse relationship between functions including exponential and logarithmic

Subunit: Algebra (continued)
Competencies:

A28 Analyze and describe errors and error sources that can be made when using computers and calculators to solve problems
A29 Decide whether problem situation is best solved using computer, calculator, paper and pencil, or mental arithmetic/estimation techniques
A30 Explore relationships between complex numbers and vectors
A31 Make arguments concerning limits, convergence and divergence in context involving sequences, series, and other types of functions
A32 Represent transformations in plane with matrices
A33 Contrast and compare algebra's of rational, real, and complex numbers with characteristics of a matrix algebra system
A34 Construct polynomial approximations of a function over specified intervals of convergence
A35 Examine complex numbers as zeros of functions
A36 Translate verbal statements into symbolic language
A37 Simplify algebraic expressions
A38 Use laws and exponents (including scientific notation)
A39 Expand and extend idea of vectors and linear algebra to higher dimensional situations
A40 Use the idea of independent basis elements for a vector space and associated fundamental concepts of finite dimensional linear algebra
A41 Develop and communicate arguments about limit situations
A42 Use matrices to describe and apply transformations
A43 Develop and use polar and parametric equations to represent problem situations
A44 Explore proofs by mathematical induction

Subunit: Geometry
Competencies:

G1	Create and interpret drawings of three-dimensional objects
G2	Represent problem situations with geometric models and apply properties of figures
G3	Apply Pythagorean theorem
G4	Demonstrate knowledge of angles and parallel and perpendicular lines
G5	Explore inductive and deductive reasoning through applications to various subject areas
G6	Translate between synthetic and coordinate representations
G7	Identify congruent and similar figures using transformation with computer programs
G8	Deduce properties of figures using transformations and coordinates
G9	Use deductive reasoning
G10	Explore compass and straightedge constructions in context of geometric theorems
G11	Demonstrate knowledge of and ability to use proof
G12	Use variety of proof techniques (e.g., synthetic, transformational, and coordinate)
G13	Use variety of proof formats, including T-proof (i.e., two-column) and paragraph proof
G14	Explore different proof strategies
G15	Investigate different proofs of theorems
G16	Develop knowledge of an axiomatic system
G17	Apply transformations and coordinates in problem solving
G18	Represent problem situations with geometric models and apply properties of figures
G19	Deduce properties of figures using vectors
G20	Analyze properties of Euclidean transformations and relate translations to vectors
G21	Apply vectors in problem solving
G22	Develop further knowledge of axiomatic systems by investigating and comparing various geometry's

Subunit: Patterns, Relations, and Functions
Competencies:

P1 Model real-world phenomena with polynomial and exponential functions
P2 Explore relationship between zeros and intercepts of functions
P3 Translate among tables, algebraic expressions, and graphs of functions
P4 Use graphing calculator or computer to generate graph of a function
P5 Explore relationship between a linear function and its inverse
P6 Describe and use characteristics of polynomial functions in problem-solving situations
P7 Explore conic sections and graph using graphing calculator or computer
P8 Apply trigonometric functions to problem situations involving triangles
P9 Discover relationships between algebraic description, kind, and properties of conic
P10 Explore periodic real-world phenomena using sine and cosine functions
P11 Analyze effects of parameter changes on graphs
P12 Use graphing calculator or computer to graph functions
P13 Develop an knowledge of rational and transcendental functions
P14 Understand connections between trigonometric and circular functions
P15 Use circular functions to model periodic real-world functions
P16 Solve trigonometric equations and verify trigonometric identities
P17 Understand connections between trigonometric, exponential, and logarithmic functions and polar coordinates, complex numbers, and series
P18 Model real-world phenomena with a variety of functions
P19 Graph using polar coordinates
P20 Explore graphs in three dimensions
P21 Explore functions of several variables
P22 Explore recursive functions using spreadsheets and/or programming languages

Unit: Science Literacy

NOTE: This content was extracted from the 9-12 cluster of Ohio's Draft Model Science Program. Due to statewide initiatives other than Tech Prep, this literacy unit was not altered to meet competency-based criteria. Each literacy unit forms a critical link between academic teachers and members of business, industry, and labor. [See "The TCP Process" for more information.]

Subunit: Scientific Inquiry
Competencies:

Q1 Check the appropriateness and accuracy of measures and computations using various strategies (e.g., estimations, unit analysis, determination of significant figures)

Q2 Use ratios, proportions, and probabilities in appropriate problem situations

Q3 Translate information from and represent information in various forms with equal ease (e.g., tables, charts, graphs, diagrams, geometric figures)

Q4 Use existing algebraic formulas and create new ones in appropriate problem-solving situations

Q5 Estimate and justify probabilities of outcomes of familiar situations based on experimentation and other strategies

Q6 Invent apparatus and mechanical tools needed to perform unique tasks in various situations

Q7 Identify, compare, and contrast different modes of inquiry, habits of mind, and attitudes and dispositions

Q8 Design investigations that are safe and ethical (i.e., obtain consent and inform others of potential outcomes, risks and benefits, and show evidence of concern for human health and safety, concern for non-human species)

Q9 Make and read scale drawings, maps, models, and other representations to aid planning and understanding

Q10 Seek elaboration and justification of data and ideas, and reflect on alternative interpretations of the information

Q11 Use appropriate units for counts and measures

Q12 Create and use databases (electronic and other) to collect, organize, and verify data and observations

Q13 Design and conduct investigations with multiple variables

Q14 Communicate the results of investigations clearly in a variety of situations

Subunit: Scientific Inquiry (continued)
Competencies:

Q15 Examine relationships in nature, offer alternative explanations for the observations, and collect evidence that can be used to help judge among explanations

Q16 Trace the development (e.g., history, controversy, and ramifications) of various theories, focusing on supporting evidence and modification with new evidence

Q17 Select, invent, and use tools, including analog and digital instruments, to make and record direct measurements

Q18 Observe and document events and characteristics of complex systems

Q19 Explain the influence of perspective (e.g., spatial, temporal, and social) on observation and subsequent interpretations

Q20 Create multiple representations of the same data using a variety of symbols, descriptive languages, mathematical concepts, and graphic techniques

Q21 Generate testable hypotheses for observations of complex systems and interactions

Q22 Document potentially hazardous conditions and associated risks in selected homes and public areas

Q23 Participate in public debates, relying on documented and verified data to construct and represent a position on scientific issues

Q24 Construct and test models of physical, biological, social, and geological systems

Q25 Read, verify, debate, and, where necessary, refute research published in popular or technical journals of science (e.g., *Discover, Omni, Popular Mechanics*)

Q26 Explore discrepant events and develop and test explanations of what was observed

Q27 Conduct theory-based research using surveys, observational instruments, and other methods

Q28 Modify personal opinions, interpretations, explanations, and conclusions based on new information

Q29 Analyze error and develop explanations in various domains

Q30 Formulate taxonomic schemes based upon multivariate models that help to explain similarities and differences in form, distribution, behavior, survival, and origin of objects and organisms

Q31 Demonstrate various logical connections between related concepts (e.g., entropy, conservation of energy)

Q32 Account for discrepancies between theories and observations

Q33 Analyze the changes within a system when inputs, outputs, and interactions are altered

Subunit: Scientific Inquiry (continued)
Competencies:

Q34 Create, standardize, and document procedures

Q35 Determine the sources of significant disparities between the predicted and recorded results and change research procedures to minimize disparities

Q36 Research, locate, and propose applications for abstract patterns (e.g., fractals, Fibonacci sequences, string theory, orbitals)

Q37 Recognize and utilize classification systems for particles, elements, compounds, phenomena, organisms, and others for exploring and predicting properties and behaviors

Q38 Suggest and defend alternative experimental designs and data explanations (e.g., sampling, controls, safeguards)

Q39 Recognize and communicate differences between questions that can be investigated in a scientific way and those that rely on other ways of knowing

Q40 Draw conclusions based on the relationships among data analysis, experimental design, and possible models and theories

Q41 Suggest new questions as a result of reflection on and discussions about their own scientific investigations

Q42 Investigate, assess, and comment on strengths and weakness of the descriptive and predictive powers of science

Q43 Create new information from representations of data in a variety of forms (e.g., symbols, descriptive languages, graphic formats) utilizing a variety of techniques (e.g., interpolations, extrapolations, linear regressions, central tendencies, correlation's)

Subunit: Scientific Knowledge
Competencies:

K1 Investigate various types of dynamic equilibrium (e.g., biological, geological, mechanical, chemical)

K2 Investigate the relationship between the rates of energy exchange and the relative energy level of components with systems (e.g., tropic levels of ecosystems, osmosis, rate of heating and cooling, storms)

K3 Investigate patterns in the natural world (e.g., heredity, crystalline structures, population and resource distributions, diffraction, dispersion, polarization)

K4 Investigate models and theories that help to explain the interactions of components in systems (e.g., conservation of mass, energy, and momentum; food webs; natural selection; entropy; plate tectonics; chaos; relativity; social-psychology)

K5 Investigate degrees of kinship among organisms and groups of organisms

K6 Investigate the limits of the definition of life, and investigate organisms and physical systems that exist at or near these limits (e.g. viruses, quarks, black holes)

K7 Investigate estimates and measurements of a wide range of distances and rates of change

K8 Investigate the historical development of theories of change over time (e.g., natural selection, continental drift, the big bang, geologic change)

K9 Investigate physical and chemical changes in living and non-living systems (e.g., photosynthesis, weathering processes, glaciation, thermal effects of materials, energy cells)

K10 Investigate simulations of nuclear change (e.g., radioactivity, half life, carbon dating)

K11 Investigate conservation principles associated with physical, chemical, and nuclear changes

K12 Formulate descriptions of the impacts of various forms of mechanical and electromagnetic waves on various organisms on each other over time

K13 Formulate models and hypotheses for patterns in the natural world (e.g., earth structures, transportation systems, migrations, communications, constellations)

K14 Formulate explanations for the influences of objects and organisms on each other over time

K15 Formulate and interpret explanations for change phenomena (e.g., mass extinction's, stellar evolution, punctuated equilibrium, molecular synthesis)

Subunit: Scientific Knowledge (continued)
Competencies:

K16 Formulate and interpret explanations for the magnitudes of diversity at different periods of geologic time (e.g., mutation, global cataclysms, continental drift, competition, mass extinction's)

K17 Formulate interpretations of the structure, function, and diversity in a variety of organisms and physical systems (e.g., DNA and RNA variants, nucleons, interaction particles)

K18 Formulate understandings of geologic time (e.g., millennia, periods, epochs)

K19 Formulate an understanding of the historical development of the model of the universe

K20 Formulate explanations and representations of the production, transmission, and conservation of energy in biological and physical systems (e.g., weather, volcanism, earthquakes, electricity, magnetism, cellular respiration)

K21 Formulate models and hypotheses about patterns in the natural world (e.g., social behavior, molecular structure, energy transformation, entropy, randomness, aging, chaos, hormonal cycles)

K22 Formulate interpretations of the relationship between energy exchange and the interfaces between components within systems

K23a Formulate estimations for the range of energies within and between various phenomena (e.g., thermal, electromagnetic, thermonuclear, chemical, electrical)

K23b Formulate explanations for the historical development of descriptions of motions interactions and transformations of matter and energy (e.g., classical Newtonian mechanics, special and general relativity, chaos)

K24 Formulate models that can be used to describe fundamental molecular interactions in living and non-living systems (e.g., cell membranes, semiconductors).

K25 Formulate an understanding of the degree of relationship among organisms and objects based on molecular structure (e.g., proteins, nucleic acids)

K26 Formulate hypotheses and models that may account for observable events (e.g., electricity and magnetism, gravitation, atoms, bonding, chemical reactions, quantum effects, energy flow on biological systems, predator-prey relationships)

K27 Formulate models and hypotheses about change over time (e.g., natural selection, speciation, punctuated equilibrium, phyleytic gradualism, stellar evolution, plate tectonics, radioactive decay, quantum mechanical theory)

Subunit: Scientific Knowledge (continued)
Competencies:

K28	Formulate lists of limitations and propose refinements of standard classification systems (e.g., periodic table, IUPAC, Linnean, standard model)
K29	Formulate specific cases of limitations and possible exceptions of theories and principles regarding the interactions of moving objects and organisms (e.g., fluid flow in vessels, motion near the speed of light, Heisenberg uncertainty principle, meteorological prediction, local variation and diversity, predicting earthquakes, energy transport in cellular respiration)
K30	Formulate plans and contingencies that can be used to accommodate for changes to and stresses on systems (e.g., wildlife and habitat management, corrosion prevention, noise abatement, structure design)
K31	Formulate models of molecular, atomic, ionic, and subatomic structures and the physical and biological implications of these structures (e.g., genes, nucleons, quarks)
K32	Formulate estimates for a wide range of measurements and scales (e.g., angstroms to light years)
K33	Formulate and interpret representations of time from origin to present accounting for phenomena of scale (e.g., smoothness, punctuation's, chaos)
K34	Formulate interpretations of the historical development of various theories of possible causes of diversity among physical and biological phenomena (e.g., the works of Aristotle, Mendel, Darwin, McClintock)
K35	Formulate models and hypotheses that can be used to explain the interactions of components within technological and ecological systems

Subunit: Conditions for Learning Science
Competencies:

C1 Participate actively in dialogue about and resolution of community issues

C2 Assess information from various countries in the original language or translated form to ascertain the perspectives of many cultures

C3 Analyze the scientific ideas presented in science fiction stories and films

C4 Perform and repeat investigations to verify data, determine regularity, and reduce the impact of experimental error

C5 Present the results of investigations in a variety of forums

C6 Contribute to the decisions regarding topics for investigation

C7 Use various creative means to communicate interpretations of scientific ideas, concepts, phenomena, and events

C8 Consider the scientific thinking and language of others

C9 Individually and collaboratively produce clearly written representations of investigative results

C10 Fulfill responsibilities as part of a research group

C11 Select and utilize resources by various criteria (e.g., efficiency, effectiveness, health, safety) that are appropriate to the investigations being conducted by groups

C12 Present persuasive argument based on the scientific aspects of controversial issues

C13 Collect, store, retrieve, and manipulate information with available t technologies alleges that may range from hand processes up through computer applications

C14 Investigate social issues with a scientific perspective (e.g., human rights, wellness, economics, futurism, environmental ethics)

C15 Keep journals of observations and inferences made over an extended period of time and reflecting upon the impact of these recorded ideas on their thinking and actions

C16 Examine the intellect, perspectives, and ethics of notable scientists

C17 Collect and analyze observations made over extended periods of time and compare these to scientific theories

C18 Create presentations of scientific understandings using diverse modes of expressions

C19 Conduct formal scientific debates in the classroom

C20 Wonder about the likelihood of events that may occur by chance or coincidence

C21 Plan and conduct field trips and experiences for small and large groups

C22 Analyze the historical context which leads to and has lead to scientific t theories

Subunit: Conditions for Learning Science (continued)
Competencies:

C23 Seek information on topics of personal scientific interest from a variety of sources
C24 Conduct learner-developed investigations independently and collaboratively over periods of week and months
C25 Listen attentively and critically to presentations of scientific information made by others
C26 Conduct analyses of propaganda related to scientific issues
C27 Perform investigations that require observations over varying periods of time
C28 Experience scientific concepts as interpreted by other cultures through multimedia and local and global specialists
C29 Access appropriate technology to perform complicated, time-consuming tasks
C30 Relate historical accounts of science to the cultural context in which they were written
C31 Work as a contributing member of a collaborative research group
C32 Examine the influences of social and political structures and realities that contribute to inquiry about scientific issues
C33 Use technology (e.g., desktop publishing, teleconferencing, networking) to communicate scientific ideas
C34 Explore and analyze a variety of perspectives on science (e.g., works by men and women of many racial, ethnic, and cultural groups)
C35 Lead groups of learners of various ages in designing, planning, and conducting science activities
C36 Respect the scientific thinking of others and self
C37 Recognize and contrast different epistemologies
C38 Develop possible courses of action in response to scientific issues of local and global concern
C39 Determine the validity of research conclusions in relation to the design, performance, and results
C40 Develop multimedia presentations of group and individual research projects and investigations appropriate for a variety of audiences and forums
C41 Produce interesting and scientifically correct stories and present them using various modes of expression
C42 Reflect on the ideas and content found in their own journal records
C43 Examine ambiguous results and formulate explanations
C44 Recognize and synthesize the contributions to scientific thought of individuals from many cultures

Subunit: Conditions for Learning Science (continued)
Competencies:

C45	Construct models and simulations of the component structures and functions of living and non-living entities
C46	Lead multi-age groups in the examination of and planned resolution for scientific issues
C47	Recognize and choose members of research teams based upon the merit of their ideas and skills
C48	Construct a portfolio of products, documentation, and self-evaluations of his/her own abilities, skills, and experiences
C49	Synthesize scientific information from a variety of sources
C50	Evaluate and prioritize scientific issues based upon risk-benefit analyses
C51	Refining scientific skills from a variety of experiences

Subunit: Applications for Science Learning
Competencies:

A1 Answer student-determined questions by designing databases and drawing inferences from the analyses of the information in these data bases
A2 Make personal behavior decisions by interpreting information that has a scientific basis
A3 Propose courses of action that will validate and demonstrate personal understandings of scientific principles
A4 Guide other learners in their understanding of the interactions of technologies and society at various periods in time
A5 Promote and carry out practices that contribute to a sustainable environment
A6 Study and propose improvements in public services and systems in their community
A7 Choose consumer materials utilizing personal and environmental risk and benefit information
A8 Make inferences and draw conclusions using databases, spreadsheets, and other technologies
A9 Do simple trouble-shooting on common electrical and mechanical systems, identifying and eliminating possible causes of malfunctions
A10 Construct devices that perform simple, repetitive actions
A11 Investigate the functionality of various geometric shapes in the natural world and the designed world (e.g., translations from spherical to plane representations cause distortions, triangular shapes contribute to rigidity and stability in structures, round shapes minimize boundary for a given capacity)
A12 Make decisions regarding personal and public health
A13 Evaluate the social and ecological risks and benefits resulting from the use of various consumer products
A14 Analyze the contributions of advances in technology through history to his/her everyday life
A15 Identify and reduce risks and threats to a sustainable environment
A16 Extend the limits of human capabilities using technological enhancements
A17 Use and recognize various propaganda techniques
A18 Solve unique problems using the results of systematic analyses
A19 Choose everyday consumer products that utilize recent innovation and pass appropriate performance criteria
A20 Refine personal career interests through investigations of the diversity of manufacturing, research, service, and invention processes

Subunit: Applications for Science Learning (continued)
Competencies:

A21 Predict and investigate the working of toys and tools while controlling and manipulating variables (e.g., friction, gravity, forces)
A22 Write, follow, modify, and extend instructions (e.g., equations, algorithms, formulas, flow diagrams, illustrations)
A23 Create products, make inferences, and draw conclusions using databases, spreadsheets, and other technologies
A24 Predict various scenarios and propose solutions to community issues using scientific information (e.g., actuarial tables, census data, topographic maps, incidence data, climatic data)
A25 Use scientific evidence to consider options and formulate positions about the health and safety of others and him/herself
A26 Search for, use, create, and store objects and information using various strategies and methods of organization and access
A27 Research and write environmental impact statements of his/her own design
A28 Compare school-based science perspectives with those gained through cutting-edge technological applications
A29 Design management plans for natural and human-altered environments (e.g., woodlots, patios, lots, lawns, farmlands, forests)
A30 Refine personal career interests
A31 Promote public awareness of the interaction of technology with social i issues
A32 Advocate and propose courses of action for local and global scientific issues using global networks
A33 Use appropriate technologies to prepare and present the findings of investigations incorporating tables, graphs, diagrams, and text
A34 Make informed consumer choices by evaluating and prioritizing information, evidence, and strategies
A35 Develop an informed point-of-view that allows for validation or refutation of the scientific statements and claims of advocated before pursuing courses of action (e.g., contributing support, signing petitions, casting votes)
A36 Differentiate between observations and inferences in the exploration of evidence related to personal, scientific, and community issues
A37 Develop and write environmental impact and safety and hygiene management plans
A38 Use technology to collect, analyze, and communicate information (e.g., electronic networks, desktop publishing, remote sensing, graphing calculators, satellite telemetry, and others)
A39 Design, construct, and market inventions

Unit: Technology Literacy

NOTE: Over 500 Ohio business, industry, and labor representatives examined, altered, and then verified the content for this unit during the TCP Process. The original content was extracted from the Report of the Task Force on Technology Competence—Learner Goals for All Minnesotans, published by the Minnesota State Council on Vocational Technical Education. The Technology Literacy unit forms a critical link between all teachers and stresses the importance of technological impact on teaching and learning. [See "The TCP Process" for more information.]

Competencies:

T1 Demonstrate a systems view of technology based on the interdependence of social, political, economic, and ecological systems

T2 Assess the career, family, and personal development implications of technological change

T3 Demonstrate continuous learning via technology

T4 Demonstrate global appreciation for technology's potential effects on cultures, geographic areas, and the environment

T5 Apply historical perspective on technology to the development and use of new technologies

T6 Apply diverse technologies to store, access, process, create, and communicate information needed to solve problems

T7 Apply legal principles and ethical conduct to the use of technology

T8 Demonstrate competency in mathematics, science, social sciences, communication, and computer skills through the analysis, design, and evaluation of technological systems

T9 Analyze the potential of alternative technological systems to solve problems and/or to extend human capabilities

T10 Use a variety of tools, materials, and equipment in solving problems and extending human capabilities

T11 Assess risks and benefits of technological developments from an ecological, economic, social, and political perspective

T12 Value human diversity as part of a team in suggesting, designing, and testing solutions to technological problems

Unit: Employability Skills

Competency: Develop a career plan

Competency Builders:

Identify current interests and aptitudes
Identify common barriers to employment
Describe strategies to overcome employment barriers
Locate resources for finding employment
Research job trends
Identify career options
Identify advantages and disadvantages of career options (in addition to other than monetary)
Identify job requirements
Investigate education/training opportunities
Evaluate personal strengths and weaknesses

Competency: Prepare for employment

Competency Builders:

Identify traditional and non-traditional employment sources
Identify present and future employment opportunities (by geographic location)
Research job opportunities, including non-traditional careers
Compare salary ranges and benefit packages
Compile occupational profile
Identify rights and responsibilities of equal employment opportunity laws
Design resume and cover letter
Target resume
Secure references
Investigate generic and specific employment tests (e.g., civil service exam; drug screening)
Use follow-up techniques to enhance employment potential
Demonstrate legible written communication skills using correct grammar, spelling, punctuation, and concise wording
Describe methods for handling illegal questions on job application forms and during interviews
Write letter of application
Research prospective employer and services performed
Explain critical importance of personal appearance, hygiene, and demeanor
Interpret job description
Demonstrate appropriate interview question and answer techniques
Demonstrate methods for handling difficult interview questions
Evaluate job offers
Write letter of acceptance
Write letter of declination
Demonstrate good listening skills
Ask for the job tactfully
Participate in extracurricular activities (e.g., student government, community projects,)

Competency: Evaluate the importance of self-esteem as an employability skill

Competency Builders:

Identify factors that affect self-esteem
Compare effects of low self-esteem and high self-esteem
Identify strategies to promote positive self-esteem

Competency: Demonstrate job retention skills

Competency Builders:

Identify employer expectations regarding job performance, work habits, attitudes, personal appearance, and hygiene
Exhibit appropriate work habits and attitude
Demonstrate ability to set priorities
Identify behaviors to establish successful working relationships
Identify alternatives for dealing with harassment, bias, and discrimination based on race, color, national origin, sex, religion, handicap, or age
Identify opportunities for advancement
List reasons for termination
List consequences of being absent frequently from job
List consequences of frequently arriving late for work
Demonstrate interpersonal relations skills (i.e., verbal and written)
Demonstrate negotiation skills
Demonstrate teamwork
Follow chain-of-command
Exhibit appropriate job dedication

Competency: Demonstrate knowledge of work ethic

Competency Builders:

Define work ethic
Identify factors that influence work ethic
Differentiate law and ethics
Describe how personal values are reflected in work ethic
Describe how interactions in the workplace affect personal work ethic
Describe how life changes affect personal work ethic

Competency: Exhibit appropriate work ethic

Competency Builders:

Use time-management techniques
Avoid personal activity during work hours
Attend work as scheduled
Adhere to company and/or governmental policies, procedures, rules, and regulations
Exercise confidentiality
Demonstrate appropriate human relations skills
Adhere to rules of conduct
Accept constructive criticism
Offer constructive criticism
Take pride in work
Resolve conflict
Manage stress
Avoid sexual connotations and harassment
Adjust to changes in the workplace
Demonstrate punctuality
Assume responsibility for personal decisions and actions
Take responsibility for assignments
Follow chain-of-command

Competency: Apply decision-making techniques

Competency Builders:

Identify decision to be made
Identify ownership of decision to be made
Identify possible alternatives and their consequences
Make decisions based on facts, legality, ethics, goals, and/or culture
Apply time factor(s)
Present decision to be implemented
Evaluate decision made
Take responsibility for decision

Competency: Apply problem-solving techniques

Competency Builders:

Identify problem
Select appropriate problem solving tools/techniques
Identify root problem cause(s)
Track root problem cause(s)
Identify possible solutions and their consequences (e.g., long term, short term, crisis)
Use resources to explore possible solutions to problem
Contrast advantages and disadvantages of each solution
Identify appropriate action
Evaluate results
Identify post-preventive action

Competency: Exhibit characteristics for job advancement

Competency Builders:

Display positive attitude
Demonstrate knowledge of position
Perform quality work
Adapt to changing situations and technology
Demonstrate capability/responsibility for different positions
Identify characteristics of effective leaders
Identify opportunities for leadership in work place/community
Demonstrate initiative to affect change in workplace
Participate in continuing education/training program
Responds appropriately to criticism from employer, supervisor, or other employees
Exhibit awareness of corporate culture
Prepare for job setbacks
Exhibit continual growth based on performance evaluation
Set realistic goals

Unit: Professionalism

Competency: Project professional image

Competency Builders:

Define professionalism
Exhibit professional appearance
Exhibit professional manners
Project professional attitude
Identify individuals' vital role in organization
Exhibit proper etiquette in professionally-related situations

Competency: Achieve individual and professional goals

Competency Builders:

Set flexible, realistic, and measurable goals
Identify potential barriers to achieving goals
Identify strategies for addressing barriers to goal achievement
Breakdown long-term goals into short-term goals
Prioritize goals
Commit to goals
Adjust goals
Obtain support for goals
Reward goal achievement

Competency: Manage personal finances

Competency Builders:

Explain need for personal management records
Balance checkbook
Identify tax obligations
Analyze how credit affects financial security
Compare types and methods of investments
Compare types and methods of borrowing
Compare types and methods of insurance
Compare types of retirement options/plans
Identify discriminatory vs. non-discriminatory expenditures

Competency: Support community well-being

Competency Builders:

Identify environmental, educational, and social issues
Participate in social and/or community activities

Competency: Achieve organizational goals

Competency Builders:

Evaluate personal goals in relation to organizational goals
Monitor progress by evaluating feedback
List responsibilities in relation to organization goals
Accomplish assigned tasks
Exercise responsibility in relation to organizational goals
Set appropriate personal performance standards
Communicate goals with supervisor and peers
Demonstrate knowledge of products and services
Promote organizational image and mission

Competency: Demonstrate positive relations in the workplace

Competency Builders:

Identify personality types of self and other
Identify various management styles
Support employer expectations
Support employer decisions
Accept constructive criticism
Give constructive feedback
Adapt to changes in workplace
List factors to consider before resigning
Write letter of resignation

Competency: Manage stressful situations

Competency Builders:

Accept stress as part of daily life
Identify personal and professional factors contributing to stress
Describe physical and emotional responses to stress
Evaluate positive and negative effects of stress on productivity
Identify strategies for reducing stress
Implement strategies to manage stress
Create strategies for developing and maintaining support systems

Competency: Analyze effects of family on work and work on family

Competency Builders:

Identify how family values, goals, and priorities are reflected in work place
Identify responsibilities and rewards associated with paid and non-paid work
Identify responsibilities and rewards associated with families
Explain how family responsibilities can conflict with work
Explain how work can conflict with family responsibilities
Explain how work-related stress can affect families
Explain how family-related stress can affect work
Identify family support systems and resources
Identify work-related support systems and resources
Communicate with family regarding work

Competency: Apply lifelong learning skills

Competency Builders:

Define lifelong learning
Identify factors that cause need for lifelong learning
Analyze effects of change
Identify reasons why goals change
Describe importance of flexibility and adaptability
Evaluate need for continuing education/training

Competency: Manage professional development

Competency Builders:

Identify career opportunities
Modify career plan
Participate in continuing education/training opportunities
Document continuing education/training
Read profession-related manuals, technical journals, and periodicals
Attend meetings, workshops, seminars, conferences, and demonstrations
Participate in professional organizations
Build personal/professional mentor relationship
Build personal/professional support system
Build professional network
Strengthen communication skills
Strengthen leadership skills
Strengthen management skills

Unit: Teamwork

Competency: Demonstrate knowledge of teamwork

Competency Builders:

Define empowerment
Differentiate work groups and teams
Identify conditions essential to teamwork (e.g., brainstorming)
Explain influence of culture (e.g., corporate, community) on teamwork
Identify appropriate situations for using teams
Define team structures (e.g., cross functional, quality improvement, task force, quality circles)
Identify team building concepts
Describe characteristics and dynamics of teams
Identify characteristics of effective team leaders and members
Identify responsibilities of a valuable team member
Identify methods of involving each member of a team
Explain how individuals from various backgrounds contribute to work-related situations (e.g., technical training, cultural heritage)
Explain the purpose of facilitators
Define consensus
Define reward/recognition system

Competency: Demonstrate teamwork

Competency Builders:

Identify purpose of team and intended goal (include time frames)
Structure team around purpose
Define responsibilities of team members
Contribute to efficiency and success of team
Work toward individual and team milestones
Analyze results of team project
Facilitate a team meeting
Assist team member(s) with problem
Monitor time frame
Stress continuous improvement
Accept failure as part of learning

Competency: Use teamwork to solve problems

Competency Builders:

Identify appropriate situations for using teams
Use problem-solving process in a team setting
Identify quality management processes/techniques
Identify quality assurance processes/techniques
Prepare presentation

Competency: Conduct team meetings

Competency Builders:

Plan agenda
Schedule meeting and location
Invite appropriate personnel
Solicit outside speakers as needed
Assign someone to take minutes
Facilitate introductions
Invite questions and comments and group participation
Focus team on agenda items
Assign appropriate action, time frame and accountability to tasks
Monitor time
Close meeting on time
Publish minutes in timely manner
Set ground rules
Avoid placing individual agendas above the group's agenda

Unit: Quality Assurance

Competency: Demonstrate knowledge of quality assurance

Competency Builders:

Explain the historical evolution of quality assurance (e.g., Deming, ISO 9000)
Explain changes brought about by quality leaders in the world
Explain the ISO 9000 process
Define quality terms
Define quality functions
Identify features of quality planning
Describe control devices used in functional areas (e.g., SPC, equipment)
Explain the relationship among organizational structures, policies, procedures, and quality assurance
Explain importance of internal and external customers
Identify internal and external customers
Describe successful efforts by industry to improve quality and/or reduce costs
Differentiate prevention and detection
Differentiate variable and attribute data
Identify types of coontrol charts
Explain how statistical techniques are tools used to control quality (e.g., SPC, DOE, CR)

Competency: Demonstrate knowledge of quality cost implications

Competency Builders:

Identify cost/quality objectives
Classify costs (i.e., direct and indirect, fixed and variable, methods and standards)
Classify quality costs (i.e., prevention, evaluation, pre-delivery failure, post-delivery failure)
Define produce liability
Interpret quality cost reports
Explain consumerism and liability prevention
Define safety terms of product
Identify safety responsibility within organization
Define contracts and torts
Differentiate express and implied warranty
Differentiate warranty and product liability
Explain how warranties are part of contract law
List questions that would need answering in liability claim

Competency: Demonstrate knowledge of engineering a quality product

Competency Builders:

Associate customer satisfaction with product characteristics (e.g., usefulness, price, operation, life, reliability, safety, cost of operation)
Define manufacturability
Identify steps in product design (e.g., brainstorming, thumbnail sketches, rendering)
Define reliability factors (e.g., cost, human, producibility)
Identify ways reliability is achieved (e.g., maintainability, good design, design simplification, design redundancy)
Explain the relationship of maintainability to reliability
Define failure
Explain the role of testing and reliability
Define value engineering
Define quality objectives
Identify cost components as they relate to quality objectives
Classify quality costs (i.e. preventive, evaluation, pre-delivery failures, post delivery failures)
Describe predictive maintenance

Competency: **Explain importance of interdepartmental relationships to quality assurance**

Competency Builders:

Explain need for everyone's commitment in assuring quality
Explain phrase "Everyone is a customer/supplier"
Define quality improvement team models
Explain the importance of top management's support of quality
Explain project selection
Explain project implementation
Explain project evaluation
Explain continuing improvement
Describe future trend of experiment design
Describe future trend of predictive maintenance

Competency: **Manipulate quality cost data**

Competency Builders:

Develop quality cost data
Translate cost reports
Graph quality cost data (e.g., pareto)

Competency: **Manipulate cost control data**

Competency Builders:

Develop cost control data
Analyze cost control reports
Provide cost control data
Provide advice on "Make or Buy" decisions (including economical lot size decisions)

Competency: Demonstrate knowledge of basic statistics

Competency Builders:

Describe data collection methods
Collect data
Organize data by flow chart
Interpret data by cause and effect diagrams
Define nominal, ordinal, interval, and ratio data
Define mean, median, and mode
Explain significance of standard deviation
Explain normal distribution

Competency: Demonstrate knowledge of scattergrams

Competency Builders:

Construct scattergram
Interpret for positive, negative, or no correlation between X and Y variables
Test for significance between one and five percent
Explain regression analysis

Competency: Demonstrate knowledge of probability theory

Competency Builders:

Define classical probability
Define empirical probability
Calculate probability for outcomes

Competency: Demonstrate knowledge of precontrol

Competency Builders:

Explain uses of precontrol
Calculate precontrol limits
Explain significance of the limits
Plot values on a precontrol chart
Explain "out-of-control" situation
Make decisions on green, yellow and red conditions

Competency: Demonstrate knowledge of process capability

Competency Builders:

Use X, R, USL, and LSL to determine process capability (upper and lower specification limits)
Calculate estimated process standard deviation
Plot right hand and left hand tail of process variation
Compute Z value for percent of probable defect for process
Calculate C_{PK} values that describe process capability
Describe skewed distributions
List probable causes of skewed distribution

Competency: Use quality control charts

Competency Builders:

Identify operational definitions for attribute criteria
Interpret histogram
Interpret scattergrams
Interpret NP chart
Interpret P chart
Interpret flowchart
Interpret cause-and-effect diagram
Construct P (percentage defective) chart for attributes
Plot control limits of P chart and data points
Check chart for out-of-control conditions
Construct an NP (number defective) chart with control limits and data
Construct C (count of defects) and U (number of defects per unit) charts
Check data on C and U charts
Construct flowchart
Construct cause-and-effect chart

Competency: Interpret $\bar{X}$ and R charts

Competency Builders:

Plot percentages for normal distribution
Test distribution for normality
Explain difference between common cause and special cause
Define an "in-control" process
Explain significance of an out-of-control point on $\bar{X}$ or R chart
Identify patterns and trends on control chart
Identify run up and run down
Test for middle third on control chart
Explain significance of middle third on control chart
Explain Rule of Sevens

Competency: Construct $\overline{X}$ and R charts

Competency Builders:

Arrange data into statistical sub-groups
Explain importance of random sampling
Compute $\overline{X}$ (i.e., average of values) and R (i.e., range of values in subgroup) within sample
Plot in $\overline{X}$ and R on chart
Construct control chart with $\overline{\overline{X}}$ (grand average) and $\overline{R}$ (average range) calculated
Calculate upper and lower control limits for $\overline{X}$-chart
Calculate upper and lower control limits for R-chart

Competency: Conduct process improvement studies

Competency Builders:

Analyze production methods and processes applying statistical process improvement techniques (e.g., SPC, C_{PK})
Identify appropriate statistical techniques for study (e.g., T-tests, F-test, capability, DOEX)
Identify major steps in conducting a study
Define "report" for a study (e.g., goal, objective, study conduct, results, conclusions, discussions)
Integrate results into the total system

Competency: **Demonstrate knowledge of JIT**

Competency Builders:

Define just-in-time concept (JIT)
Describe various production methodologies (e.g., standard cycle times, routings, standard quantities, multiple-machine tending)
Describe types of inventory control (e.g., Kanban)
Describe importance of flexibility
Differentiate product layout, process layout, fixed position layout, and cellular layout
Differentiate straight-line, U-shaped, S-shaped, convoluted and comb patterns
Describe advantages/disadvantages of layout and patterns
Explain importance of product protection, identification and storage
List methods of identifying products (e.g., labels, bar codes, radio frequency systems and magnetic strip systems)
Describe manual methods of storage and retrieval
Describe automated storage and retrieval systems (ASRS)
Describe automated guided vehicle moving systems (AGVS)

Competency: **Apply JIT**

Comptency Builders:

Maintain system for physical handling and movement of material in-process and in-storage
Monitor system of physical handling and movement of material in-process and in-storage
Maintain system for physical handling and movement of finished products
Monitor system of physical handling and movement of finished products
Write requests for deviation from specifications
Implement quality control and inspection standards and procedures
Write engineering change notices and rejection reports
Monitor reports of discrepancy or rejects during production process
Conduct quality tests under different environmental conditions

Competency: Demonstrate knowledge of inspection

Competency Builders:

Explain purpose of inspection
Describe scope of inspection
Explain purpose of incoming, ongoing, and final inspections
Explain early detection inspection
Explain how statistical process control (SPC) aids inspection
Define types of nonconformance
Define degrees of nonconformance
Define corrective action
Describe when to 100% inspect
Describe when to sample inspect
Describe methods of testing for material properties (e.g., harness, strength, chemical makeup, flaws, errors in tooling or setup)
Define rework, salvage, and scrap
Describe ethical decisions an inspector may make
Identify purposes of computer-automated inspection
Explain advantages and limitations of automated inspection
Explain disposition of non-conforming material
Explain basic foolproofing concept to build inspection into process (i.e., poka-yoke)
Use checksheets to organize and record inspection results

Competency: Inspect machinery, materials, and products

Competency Builders:

Identify critical material characteristics from specification(s) or drawing(s)
Perform capability studies for machinery and materials acceptance
Identify appropriate acceptance sampling plan
Conduct incoming materials inspection using sampling plan criteria
Identify critical in-process characteristics from specification(s) or drawing(s)
Demonstrate basic metrology skills
Conduct in-process inspection
Identify appropriate inspection reports and follow-up
Gauge R and R (reproducibility and repeatability)
Apply geometric tolerancing
Explain C = O (zero) acceptance plan
Interpret instructions in a control plan

Competency: Demonstrate knowledge of nondestructive testing

Competency Builders:

Describe purpose of nondestructive testing
Identify anomalies
Define defects and discontinuities
Identify factors contributing to defects and discontinuities
Describe ultrasonic testing
Describe advantages and limitations of ultrasonic testing
Describe industrial radiography
Compare use of wet and dry particles in magnetic particle inspection
Explain advantages and limitations of penetrant inspection
Describe microwave testing
Describe holographic inspection
Explain choice of most suitable nondestructive test method
Describe eddy-current testing

Unit: Technical Recording and Reporting

Competency: Demonstrate proficiency in technical recording

Competency Builders:

Describe various documentation procedures
Interpret specifications or drawings
Observe process
Ask open-ended questions
Record process (e.g., flowchart, step-by-step)
Identify parameters
Record accurate, truthful data
Maintain test logs
Compile cumulative reference notebook/record
Measure appropriate parameters
Draft preventive maintenance and calibration procedures

Competency: Demonstrate proficiency in technical reporting

Competency Builders:

Use data books and cross reference/technical manuals
Compose technical memoranda
Identify type of report or format needed
Use appropriate format
Compile relevant data
Design charts and graphs
Analyze data
Draw conclusions
Explain analytical methods used
Outline reports
Write reports
Present reports

Unit: Computer Literacy

Competency: Describe personal computer operations

Competency Builders:

Explain how data is stored in main computer memory
Explain how computer system executes program instruction
Explain computer storage capacity
Explain how data is represented
Describe data storage techniques
Identify types of memory

Competency: Explain information processing cycle

Competency Builders:

Define operating systems (e.g., DOS, OS/2, UNIX, MAC)
Describe computer languages and their use
Describe computer languages and their use
Describe computer languages and their use
Describe difference between data files and program files
Explain PC layout
Explain PC network layout
Explain mini/mainframe network layout
Differentiate hardware and software
Differentiate open from proprietary architecture

Competency: Operate computer hardware

Competency Builders:

Practice proper media handling techniques (e.g., magnetic fields, dust, liquids)
Identify hardware and its use
Use hardware (e.g., mouse, diskettes, drive, modems, touch screen, printers, digitizers, scanners, cables, protection devices)
Keyboard efficiently
Demonstrate basic care of hardware
Explain need for and application of security levels/procedures
Perform basic hardware troubleshooting
Explain hardware addressing techniques

Competency: Use software

Competency Builders:

Define software types and functions
Describe basic disk operations and care
Perform functions necessary to operate software
List advantages and disadvantages of integrated and dedicated software
Operate system software
Operate diagnostic software
Demonstrate basic proficiency in spreadsheet use
Demonstrate basic proficiency in word processing
Demonstrate basic proficiency in database use
Demonstrate basic proficiency in network use
Demonstrate basic proficiency of utility (e.g., WINDOWS, GUI)
Demonstrate basic proficiency in report writing
Demonstrate system commands
Differentiate ethical use/misuse of software
Describe bulletin boards/electronic mail
Apply security levels/procedures while handling sensitive data
Explain data compression techniques
Explain use and deletion of passwords

Unit: Workplace Safety

Competency: Apply general safety precautions

Competency Builders:

Identify local, state, and federal rules and regulations
Identify personal protective wear and equipment
Identify visual controls (e.g., monitors, read outs)
Identify auditory controls
Identify common sense housekeeping
Interpret hazardous materials notices on containers
Use personal protective wear and equipment
Apply workplace safety rules and procedures
Apply personal safety rules and procedures
Apply workplace organization (e.g., housekeeping)
Apply applicable electrical, mechanical, steam, hydraulic and (e.g., pneumatic safety rules and procedures)
Apply fire safety rules and procedures
Apply hazardous wastes rules and procedures
Apply first aid
Locate (MSDS)
Perform lockout and tagout
Recycle scrap metal, chips, shavings, coolants, solvents, trash, and waste materials
Apply common sense housekeeping
Use preventive maintenance checklists

Competency: **Demonstrate knowledge of safety and workplace hazards**

Competency Builders:

Describe corrective procedures for unsafe conditions
Identify types and potential level of workplace hazards (e.g., physical hazards, fire, chemicals, noise, ionizing radiation, ultraviolet, temperature extremes, ergonomics, biological hazards)
Identify safety materials/equipment (e.g., absorbant socks, oil dry)
Interpret Material Safety Data Sheets (MSDS)
Explain purpose(s) of OSHA and NIOSH
Explain purpose(s) of NEC and NFPA
Identify purpose of emergency evacuation routes, master switch and lockout locations, and safety color coding systems
Identify roles of industrial hygienists, safety professionals, occupational physicians, and occupational nurses
Describe methods of evaluating potential hazards (e.g., visual analysis)
Describe methods of correcting potential hazards
Describe various types of toxicity (e.g., chronic, immediate)
Identify need for reporting accidents
Explain precautions required when using toxic or flammable materials
Define confined space and related requirements
Explain how international directives relate to safety

Competency: **Explain purpose of industrial pollution control systems**

Competency Builders:

Describe types of air, water, solid waste, and noise pollution
Explain purpose of air pollution control systems
Explain purpose of water pollution control systems
Explain purpose of solid waste pollution control systems
Explain purpose of noise pollution control systems
Explain basic philosophy of "right to know" legislation
Explain purpose(s) of EPA
Identify "costs" of industrial pollution control (i.e., dollars vs. impact to environment)
Describe ethics of environmental issues

Competency: Demonstrate knowledge of ergonomics

Competency Builders:

Define ergonomics
Define risk factor
Define maximum permissible limit (MPL) and action limit (AL) for lifting
Define cumulative trauma disorder (CTD)
Identify susceptibility factors for CTD
Minimize extreme joint movement
Minimize use of excessive muscle force
Minimize repetitive tasks
Minimize mechanical stresses (e.g., sharp edges, heat, cold, hard surfaces, weights, vibration)
Minimize awkward body positions
Explain use of rest pauses
Explain need for mats and footrest for standing jobs
Explain need for appropriate working heights of chairs, stools, workbenches, equipment
Explain need for adequate lighting
Explain use of anthropometric (i.e., centering one's view of everything around man) design

Unit: Supervision

Competency: **Perform supervisory functions**

Competency Builders:

Define supervision
Conduct task analysis
Create organizational and/or departmental charts
Apply company policies and procedures
Maintain workplace procedures manuals
Prepare budgets
Monitor budgets
Prepare managerial reports
Analyze daily production reports
Maintain appropriate work environment
Conduct tours
Facilitate assignments
Assign work
Delegate job tasks
Monitor progress
Prepare productivity reports
Provide training for new policies
Troubleshoot workplace problems
Coordinate workplace activities
Appraise performance
Document personnel issues
Coordinate administrative duties

Competency: **Coordinate training**

Competency Builders:

Assess training needs
Secure training resources, materials and equipment
Train employees
Evaluate progress of trainee
Provide feedback
Solicit feedback
Receive feedback
Assess feedback

Unit: Basic Electronics

Competency: Demonstrate proficiency in electronics fundamentals

Competency Builders:

Identify electronic components and schematic symbols
Describe basic atomic structure and its relationship to electricity
Describe the relationship between electrical and magnetic properties
Describe the electrical and magnetic properties of a magnet
Describe the photoelectric effect
Describe the thermocouple effect
Describe the electrical effect of friction
Use metric units to solve electronic unit problems
Identify sources of electricity
Describe principles and operations of electrochemical supplies
Describe voltage, current, resistance, power, and energy
Apply Ohm's Law
Apply Kirchoff's Laws
Apply power formulas
Explain Thevenin's Theorem
Explain Norton's Theorem
Interpret color codes and symbols to identify electrical components and values
Measure properties of circuits using test equipment
Describe electrostatic discharge (ESD) procedures

Competency: Demonstrate proficiency in DC circuits

Competency Builders:

Compute conductance of conductors and insulators
Measure resistance and current of conductors and insulators
Measure properties of a circuit using volt-ohm meter (VOM) and digital volt-ohm meter (DVM)
Build series, parallel, and combination circuits
Build bridge circuits
Build voltage divider circuits (loaded and unloaded)
Compute voltage divider circuits (loaded and unloaded)
Demonstrate maximum power transfer theory
Describe magnetic properties of circuits and devices
Explain physical and electrical characteristics of capacitors and inductors
Describe RC and RL time constants
Compute RC and RL time constants
Demonstrate use of diodes in DC circuits
Identify need for rectification
Operate power supplies for DC circuits
Analyze frequency spectrums
Construct the operation of DC circuits that demonstrate maximum power transfer theory
Use meters and oscilloscopes
Measure current, voltage, and resistance in DC circuits
Explain simple DC generator action
Explain simple DC motor action
Explain principals of solid-state switching devices
Solve algebraic problems to include exponential (prerequisite to DC) (algebraic calculation)
Explain use of DC in relation to communications
Identify classes, voltage ratings and/or polarity of electronic components
Identify use of circuit protective devices (e.g., fuses, breakers)
Troubleshoot DC circuits

Competency: Demonstrate proficiency in AC circuits

Competency Builders:

Analyze properties of an AC signal
Describe principles and operation of characteristics of sinusoidal and non-sinusoidal wave forms
Identify AC sources
Describe principles and operation of characteristics of capacitive circuits
Operate capacitive circuits
Describe principles and operation of characteristics of inductive circuits
Operate inductive circuits
Describe principles and operation of transformers
Demonstrate operation of AC circuits utilizing transformers
Use maximum power transfer theorems
Use Thevenin's and Norton's theorem to analyze AC circuits
Measure power in AC circuits
Operate capacitor and inductor analyzers for AC circuits
Operate differentiators and integrators to determine RC and RL time constants
Describe principles and operation of characteristics of series and parallel resonant circuits
Build series and parallel resonant circuits
Identify classes, voltage, ratings and/or polarity of electronic components
Identify use of circuit protective devices (e.g., fuses, breakers)
Describe principles and operation of characteristics of frequency selective filter circuits
Calculate logarithmic to obtain gain (dB) using tables or calculator/computer
Operate frequency selective filter circuits
Operate polyphase circuits
Describe basic motor theory and operation
Describe basic generator theory and operation
Operate power supplies for AC circuits
Describe principles and operation of various power conditioning (e.g., isolation transformers, surge suppressors, uninterruptable power systems)
Describe principles and operation of various safety grounding systems (e.g., lightning arresters, ground electrostatic discharge, fault interrupters, etc.)
Describe characteristics of inductors in series and parallel circuits
Describe characteristics of capacitance in series and parallel circuits
Compare resistive-capacitive (RC) and resistive-inductive (RL) time constants (TC)
Measure voltage, current, time, frequency (f), and phase relationships of AC sine wave signal
Describe frequency (F) and phase relationships

Competency: **Demonstrate proficiency in AC circuits (CONTINUED)**

Competency Builders:

Describe resonance of inductive-capacitive (LC) circuits
Calculate impedance match and maximum transfer of power
Measure current, voltage, and resistance in AC circuits
Identify 50/60 Hertz
Explain simple AC generator action
Explain simple AC motor action
Calculate power factor in AC circuits
Explain harmonics and its effects on power quality
Solve basic trigonometric problems as applicable to electronics
Calculate peak (PK), root mean square (RMS), and average values
Troubleshoot AC circuits

Unit: Troubleshooting and Repair

Competency: Demonstrate troubleshooting skills

Competency Builders:

Explain role of preventive maintenance
Differentiate normal and abnormal operations
Explain troubleshooting procedures
Explain logical actions taken to troubleshoot
Use proper troubleshooting aids
Demonstrate knowledge of safety rules for troubleshooting and repair procedures
Maintain troubleshooting and repair records
Interpret prints (e.g., PID, loopsheets)
Use manufacturer's manuals, schematics, and troubleshooting charts
Isolate faults, shorts, and open circuits

Competency: Apply troubleshooting techniques to DC circuits

Competency Builders:

Identify noise problems
Isolate faults in series, parallel and series parallel
Isolate faults in bridge circuits
Isolate faults in DC power supplies
Perform polarity check
Isolate faults to DC drive system
Isolate faults in voltage divider circuits
Repair faults

Competency: **Apply troubleshooting techniques to AC circuits**

Competency Builders:

Isolate faults in capacitive circuits
Isolate faults in inductive circuits
Isolate faults in AC circuits utilizing transformers (e.g., step up and step down)
Isolate faults in differentiator and integrator circuits
Isolate faults in RC, RL, and RLC circuits
Isolate faults in frequency selective filter circuits
Isolate faults to AC frequency drive systems
Repair faults

Competency: **Apply troubleshooting techniques in discrete solid-state devices**

Competency Builders:

Isolate faults in diode circuits
Isolate faults in thyristor circuitry (e.g., SCR, TRIAC, DIAC)
Isolate faults in transistor circuits
Isolate faults in operational amplifier circuits
Isolate faults in single-stage amplifiers
Isolate faults in open circuits
Repair faults

Competency: **Apply troubleshooting techniques to analog circuits**

Competency Builders:

Isolate faults in single and multistage amplifiers
Isolate faults in audio power amplifiers
Isolate faults in regulated and switching power supply circuits
Isolate faults in active filter circuits
Isolate faults in oscillator circuits
Isolate faults in operational amplifier circuits
Isolate faults in power supplies (loaded and unloaded) and filters
Repair faults

Competency: **Apply troubleshooting techniques to digital circuits**

Competency Builders:

Identify noise problems
Isolate faults in multiplexer and demultiplexer circuits
Isolate faults in digital display circuits
Isolate faults in logic gates
Isolate faults in flip-flops
Isolate faults in registers and counters
Isolate faults in clock and timing circuits
Isolate faults in arithmetic-log circuits
Isolate faults in encoders and decoders
Isolate faults in digital-display devices
Repair faults

Competency: **Apply troubleshooting techniques to a microcomputer system**

Competency Builders:

Isolate faults to systems boards
Isolate faults to memory circuits
Isolate faults to data storage devices
Isolate faults in power supplies
Troubleshoot I/O ports
Isolate faults in I/O interface circuitry
Use diagnostic software
Repair faults

Competency: **Apply troubleshooting techniques to manufacturing systems**

Competency Builders:

Identify individual process blocks of assembly line or process
Identify process block interfaces
Demonstrate steps required for efficient systems troubleshooting
Isolate system faults to process block
Isolate block faults using schematics
Isolate block faults using programmable controller indicators
Isolate block faults using volt meter
Repair block faults by replacing fault component or wiring

Unit: Industrial Electricity

Competency: **Explain basic industrial electricity theory**

Competency Builders:

Describe atomic structure and its relationship to electricity
Describe the relationship between electrical and magnetic properties
Describe the electrical and magnetic properties of a magnet
Describe the photoelectric effect
Describe the thermocouple effect
Describe the electrical effect of friction
Identify sources of electricity
Identify potential sources of electricity
Describe differences between AC/DC
Describe effects varying degrees of electricity have on the human body

Competency: **Use the National Electrical Code (NEC)**

Competency Builders:

Use NEC to identify correct materials
Use NEC to identify correct methods
Use NEC to identify correct applications
Use NEC to identify correct safety procedures

Competency: **Explain operation of electrical distribution systems**

Competency Builders:

Follow NFPA, local, state, and national codes
Describe functions of permits and licensing requirements
Explain generation of electricity
Explain transmission of electricity
Explain end user distribution

Competency: Maintain basic electrical systems

Competency Builders:

Replace electrical cords
Replace batteries
Replace fuse(s)
Replace switches and other sensors
Replace plugs and sockets
Replace control panel components (e.g., relays, motor starters)
Replace AC motors (e.g., 3 phase, single phase)
Replace DC motors

Competency: Interpret electrical/electronic drawings

Competency Builders:

Interpret basic electric/electronic standards and symbols (e.g., NEC, IEC)
Interpret schematic drawings
Interpret cable drawings
Interpret component drawings
Interpret logic diagrams
Interpret control panel drawings
Interpret connection drawings
Interpret interconnection drawings
Interpret printed circuit board drawings
Interpret harness drawings
Interpret package drawings
Interpret mechanical/electronic production blueprints and assembly drawings

Competency: **Demonstrate proficiency in direct current (DC) circuits**

Competency Builders:

Describe voltage, current, resistance, power, and energy
Solve algebraic problems to include exponential (prerequisite to DC)
Measure properties of a circuit using volt-ohm meter (VOM) and digital volt-ohm meter (DVM) meters and oscilloscopes
Apply Ohm's Law
Construct parallel circuits
Construct series circuits
Construct series parallel and bridge circuits
Define voltage divider circuits (loaded and unloaded)
Construct DC circuits that demonstrate the maximum power transfer theory
Solve problems in electrical units utilizing metric units
Describe the principles and operation of electrochemical supplies
Apply Kirchoff's law
Interpret color codes and symbols to identify electrical components and values
Measure properties of a circuit using analog and digital meters and oscilloscopes
Measure conductance and resistance of conductors and insulators
Describe magnetic properties of circuits and devices
Describe the physical and electrical characteristics of capacitors and inductors
Describe RC and RL time constants
Set up power supplies for DC circuits
Operate power supplies for DC circuits
Analyze frequency spectrums
Apply Thevenin's and Norton's theorems

Competency: **Demonstrate proficiency in alternating current (AC) circuits**

Competency Builders:

Solve basic trigonometric problems as applicable to electricity (prerequisite to AC)
Analyze AC signals utilizing VOM, DVM, oscilloscope, frequency counter and function generator
Analyze power in AC circuits
Measure power in AC circuits
Operate capacitor and inductor analyzers for AC circuits
Analyze properties of an AC signal
Describe the principles and operation of the characteristics of sinusoidal and non-sinusoidal wave forms
Identify AC sources
Describe the principles and operation of the characteristics of capacitive circuits
Demonstrate the operation of capacitive circuits
Describe the principles and operation of the characteristics of inductive circuits
Demonstrate the operation of inductive circuits
Describe the principles and operation of the principles of transformers
Demonstrate the operation of AC circuits utilizing transformers
Operate differentiators and integrators to determine RC and RL time constants
Describe the principles and operation of the characteristics of RLC circuits (series, parallel, and complex)
Demonstrate the operation of RLC circuits (series, parallel, and complex)
Describe the principles and operation of the characteristics of series and parallel resonant circuits
Operate series and parallel resonant circuits
Describe the principles and operation of the characteristics of frequency selective filter circuits
Demonstrate the operation of frequency selective filter circuits
Operate polyphase circuits
Describe basic motor theory and operation
Describe basic generator theory and operation
Operate power supplies for AC circuits
Describe the principles and operation of various power conditioning (e.g., isolation transformers, surge suppressors, uninterruptable power systems)
Describe the principles and operation of various safety grounding systems (e.g., lightning arresters, ground fault interrupters, etc.)
Apply maximum power transfer theorems
Apply Thevenin's and Norton's theorems to analyze AC networks

Unit: Electrical Test and Measurement Equipment

Competency: **Demonstrate proficient use of electrical test equipment**

Competency Builders:

Describe function and operation of logic probe and logic analyzer
Describe function and operation of power monitor
Describe function and operation of signal generator
Describe function and operation of spectrum analyzer
Describe function and operation of AC/DC hi-pot
Describe function and operation of time-domain reflectometer (TDR)
Describe function and operation of megger
Describe function and operation of curve tracer/analogger
Apply test equipment to DC circuits
Apply test equipment to AC circuits
Apply test equipment to solid-state devices
Apply test equipment to digital circuits
Apply test equipment to analog circuits
Apply test equipment to microprocessors

Competency: **Demonstrate proficient use of electrical measurement equipment**

Competency Builders:

Describe function and operation of analog volt-ohm-meter (AVOM)
Describe function and operation of digital volt-ohm-meter (DVOM)
Describe function and operation of amp probe
Describe function and operation of oscilloscopes
Describe function and operation of operation of infrared heat sensor
Apply measurement equipment to DC circuits
Apply measurement equipment to AC circuits
Apply measurement equipment to solid-state devices
Apply measurement equipment to digital circuits
Apply measurement equipment to analog circuits
Apply measurement equipment to microprocessors

Unit: Drafting Technology

Competency: **Apply basic drafting skills**

Competency Builders:

Use drafting equipment, measuring scales, drawing media, drafting instruments and consumable materials, blueprint machine
Identify line styles, weights (alphabet of lines)
Select proper drawing scale, introduction to different types
Prepare title blocks and other drafting formats
Apply freehand and other lettering techniques
Prepare multi-view drawings
Prepare multi-view sketches
Prepare orthographic views
Prepare change control block
Describe change control block/revision block
Measure angles
Draw horizontal, vertical, angular, parallel, and perpendicular lines
Transfer an angle
Construct tangent lines (to arcs) and tangent arcs (to arcs)
Bisect angles and arcs
Bisect lines
Divide lines
Construct three-point circle
Construct regular hexagon, pentagon, and octagon
Reproduce a drawing
Prepare single-view drawings
Prepare dimension drawings
Interpret notes and dimensions to determine part
Draw arcs, circles, and conics
Transfer measurements

Competency: Apply intermediate drafting skills

Competency Builders:

Describe types of blueprints and their applications
Apply isometric, oblique and perspective sketching techniques
Prepare isometric, oblique and perspective sketches
Prepare sectional views
Prepare auxiliary views
Identify ANSI symbols
Prepare views of drilled and tapped holes, counterbores, countersinks
Apply systems drafting techniques
Identify a bill of materials
Dimension drawings using ANSIy14.5 standards
Describe purpose of auxiliary and sectional views

Competency: Apply advanced drafting skills

Competency Builders:

Interpret reports and specifications
Prepare pictorial drawings
Prepare schematics
Draw conics
Interpret basic pneumatic/hydraulic standard and symbols
Interpret various drawings (e.g., welding, casting, stamping, forging, civil, maps, pattern shop)

Competency: Interpret basic prints

Competency Builders:

Visualize object from drawing
Interpret orthographic projections
Interpret isometric views
Interpret sectional views
Interpret detail and assembly drawings
Interpret dimensions
Interpret tolerances

Competency: Interpret intermediate prints

Competency Builders:

Interpret screw thread specifications
Identify structural steel shapes
Interpret special symbols
Interpret electrical, pneumatic/hydraulic drawings
Interpret schematics

Competency: Interpret advanced prints

Competency Builders:

Interpret GD&T characteristic symbols
Interpret GD&T supplementary symbols

Competency: **Demonstrate knowledge of basic geometric dimensioning and tolerancing**

Competency Builders:

Identify geometric characteristics and symbols (i.e., flatness, straightness, roundness, cylindricity, profile of line, profile of surface, perpendicularly, angularity, parallelism, circular, runout, total indicated runout, position, concentricity, and symmetry)
Define maximum material condition
Define least material condition
Define regardless of feature size condition
Describe feature control blocks
Describe datum surfaces and targets
Define flatness (pitch)
Define straightness (yaw)
Define roundness
Define cylindrically
Define profile of line
Define profile of surface
Define perpendicularity
Define angularity
Define parallelism
Define circular runout
Define total runout
Define true position concept to determine tolerance for location of holes in mating parts

Competency: **Convert dimensions and tolerances**

Competency Builders:

Convert dimensions and tolerances from English units to metric units
Convert dimensions and tolerances from metric units to English units

Competency: Apply revision control process

Competency Builders:

Apply drawing balloons
Apply documentation (including project filing, back-up material, tracking process)
Apply change control block
Apply revision levels

Competency: Demonstrate dimensioning techniques

Competency Builders:

Construct arrowheads using various styles/disciplines
Apply symbols for surface and texture control
Add labels/notes to drawing
Interpret decimal tolerance dimensions
Dimension arcs
Dimension angles
Dimension curves
Dimension rounded-end shapes
Dimension spherical objects
Dimension cylindrical objects
Dimension cones, pyramids, and prisms
Dimension features on circular center line
Dimension theoretical point of intersection
Dimension object using rectangular coordinate system
Dimension object using polar coordinate system
Dimension object using tabular coordinate system
Dimension object using ordinate dimensioning system

Competency: Apply geometric dimensioning and tolerancing

Competency Builders:

Interpret decimal tolerance dimensions
Calculate clearance fit tolerances of mating parts
Dimension clearance fit tolerances of mating parts
Calculate interference fit tolerances of mating parts
Dimension interference fit tolerances of mating parts
Calculate tolerances to mating parts using standard fit tables
Assign tolerances to mating parts using standard fit tables
Apply positional and form tolerancing symbols
Apply symbols for true position
Apply symbols for maximum material control and regardless of feature size
Calculate effects of dimensional stack-up
Calculate transitional fit tolerances
Dimension transitional fit tolerances

Competency: Perform basic physical layouts

Competency Builders:

Use inside diameter (ID), outside diameter (OD), and hermaphrodite calipers
Layout with combination square
Layout with scriber, divider and trammel
Use surface plate
Use surface gage
Use layout fluid
Use V-blocks
Use clamps
Use angle plate
Use parallels
Use punches
Use transfer method tools
Use layout hammer
Use machinist's square
Use universal bevel protractor
Use machinist's scale

Competency: Prepare mechanical drawings

Competency Builders:

Interpret basic mechanical standards and symbols
Prepare assembly drawings
Prepare welding drawings
Prepare bearing drawings
Prepare casting drawings
Prepare forging drawings
Prepare tool drawings
Prepare molding diagrams
Prepare drawings with special processed holes
Prepare stamping drawings
Prepare numerical control drawings/instructions
Prepare installation drawings
Prepare purchase part drawings
Prepare approval drawings

Competency: Prepare advanced mechanical drawings

Competency Builders:

Resolve problems by descriptive geometry and revolutions
Use precision dimensioning to include geometric characters
Use precision measuring instruments (e.g., calipers)
Prepare fastener drawings
Prepare cam drawings
Prepare gear drawings
Prepare spring drawings
Prepare pulley and chain drive drawings

Unit: CADD Fundamentals

Competency: Demonstrate basic use of computer operating system

Competency Builders:

Create ASCII text files with a text editor
Explain rules for naming files and directories
Manage files
Create directories
Remove directories
Change directories
Copy files
Rename files
Erase files
Format diskettes
Label diskettes
Explain the syntax of operating system commands
Use wildcards in operating system commands

Competency: Operate a CADD system

Competency Builders:

Execute CADD system
Use keyboard input
Use screen and tablet menus
Use other input devices (e.g., scanner, digitizer)
Create scaled plots
Operate a pen plotter
Operate a printer-plotter (i.e., laser plotter)
Access on-line help for commands
Use file conversion
Use data transfer

Competency: Select entities for action

Competency Builders:

Add or remove entities separately
Add or remove entities using a window
Add or remove entities with a crossing-box
Select entities using a fence
Select entities by other methods (e.g., last, previous, type, all, etc.)

Competency: Create 2-D orthographic drawings

Competency Builders:

Create primitive drawing entities
Draw utilizing absolute Cartesian coordinates
Draw utilizing relative Cartesian coordinates
Draw utilizing polar coordinates
Draw using construction aides (e.g., snaps, grid, snap, etc.)
Change drawing attributes
Edit drawing entity properties (e.g., color, layer, thickness, linetype)
Construct drawing entities (e.g., offset, timer, extend, break, mirror, etc.)
Edit drawing entities (e.g., offset, trim, extend, break, mirror, etc.)
Set system variables (e.g., units, scale)
Use system variables
Create layers
Name layers
Manipulate layers
Save files
Create back-ups
Create hatches, patterns, symbols
Recall drawing templates/blocks

Competency: Annotate orthographic drawings

Competency Builders:

Create text styles
Edit text styles
Select text styles
Apply notes

Competency: Dimension orthographic drawings

Competency Builders:

Create dimensions
Edit text
Control dimension variables/models

Competency: Control display

Competency Builders:

Apply view control while drawing (e.g., zoom and pan)
Control view resolution (e.g., viewers)
Save views
Display views

Competency: Extract entity and drawing information

Competency Builders:

Measure distances
Measure areas
Identify locations
List entity characteristics (e.g., length, size, location, properties, etc.)

Unit: Intermediate CADD

Competency: Manage symbols and attributes

Competency Builders:

Create blocks and W-blocks/templates
Create nested blocks/templates
Insert blocks and drawings/templates
Redefine blocks/templates
Edit blocks/templates
Apply attributes

Competency: Create 2-D isometric drawings

Competency Builders:

Manipulate snap and grid settings
Toggle planes (e.g., left, right, top)
Create text styles for each plane
Create dimension styles
Use dimension styles
Create isometric ellipses

Competency: Use external routines

Competency Builders:

Load AutoLISP programs
Execute AutoLISP programs
Load ADS programs
Execute ADS programs

Competency: Create custom menus

Competency Builders:

Demonstrate search routines when using a text editor
Write screen menus and macros
Write tablet menus and macros
Write cascading pop-down menus and macros
Write icon menus and macros
Write button menus and macros
Write other customizable CADD files (e.g., ACADD.PCP)
Edit other customizable CADD files (e.g., ACADD.PCP)

Competency: Create script files

Competency Builders:

Write a slide show script
Write a script for setting initial variable settings
Write a script for creating a title-block

Competency: Create custom linetypes

Competency Builders:

Formulate a linetype composed of long dashes
Formulate a linetype composed of lines, dashes and dots

Competency: Create 3-D wireframe models

Competency Builders:

Differentiate among extrusions, wireframes, surface models, and solid models
Create user coordinate systems
Manipulate user coordinate systems
Use cylindrical coordinates
Use spherical coordinates
Use .XYZ filters
Project geometry from one plane to another

Competency: **Create 3-D surface models**

Competency Builders:

Define B-rep surfaces
Differentiate B-rep surfaces and non-uniform rational B-splines (NURB's)
Create tabulated surfaces
Create ruled surfaces
Create revolved surfaces
Create edge surfaces (e.g., coon's patch)
Apply surface meshes to 3-D wireframes
Modify visibility of the edges of faces
Dimension a 3-D model for both isometric and orthographic drawings
Control dimension scale with regard to plotting scale

Competency: **Apply advanced control display techniques**

Competency Builders:

Define camera viewpoints and angle of rotation
Control display angle (e.g., d-view, v-point)

Unit: Equipment Installation

Competency: Explain installation procedures

Competency Builders:

Explain relocation procedures for new equipment in an existing facility
Explain the use of anchors and isolators
Explain procedures for moving and installing new equipment
Explain leveling and aligning procedures
Explain test run guidelines
Explain safety precautions for equipment installation procedures
Explain grounding procedures
Explain installation of utilities (e.g., electricity, air, water, drains)

Competency: Prepare for equipment installation

Competency Builders:

Identify equipment requirements (including safety)
Identify maintenance services needed
Identify method of moving and equipment needed
Identify measuring devices
Calculate weights
Follow manufacturer's specifications and mannuals
Identify applicable electrical, mechanical, hydraulic, and/or pneumatic principles
Read drawings/schematics
Revise drawings if applicable
Interpret prints

Competency: Install Equipment

Competency Builders:

Prepare site
Use measuring devices
Calculate weight
Follow manufacturer's specifications
Use appropriate moving equipment
Align equipment to layout specifications
Apply electrical, mechanical, hydraulic, and/or pneumatic principles

Competency: Explain rigging functions

Competency Builders:

Estimate the weight of a load
Find the center of gravity
Identify the rigging and slings used in maintenance work
Explain safety inspection procedures for rigging, ropes, and slings
Perform safety inspection procedures for rigging, ropes, and slings
Identify rope fiber types
Tie rigging knots, bends, and hitches
Identify types of wire rope
Cut wire rope assemblies and termination's
Identify cranes and hoists
Identify and explain scaffolding types
Identify safety equipment (e.g., life belts, nets, etc.)

Competency: Perform rigging functions

Competency Builders:

Perform safety inspection procedures for rigging, ropes, and slings
Tie rigging knots, bends, and hitches
Cut wire rope
Seize wire rope
Install wire rope eyes, sockets, and hooks
Splice wire rope
Erect a scaffold
Rig life belts and nets

Unit: Mechanical Power Transmission

Competency: Demonstrate knowledge of basic mechanics

Competency Builders:

Explain working forces of torque, tension, and compression
Explain the laws of motion
Explain how to calculate work in several ways
Explain the function of simple machines including levers, inclined plane, wedge wheel and axle, pulley and screw, gears
Explain the types of power and the method of producing power
Explain the laws of friction
Explain mechanical efficiency
Apply basic knowledge of physics
Apply basic knowledge of stress, strain, and fatigue
Calculate speed changes

Competency: Describe mechanical power transmission systems

Competency Builders:

Describe the principles and operation of compound and reverted gear trains
Describe the principles and operation of internal and planetary gear trains
Describe the principles and operation of helical and bevel gear trains
Describe the principles and operation of rack and pinion, worm and wheel, and block and screw mechanisms
Describe the principles and operation of counter rotating mechanisms and differentials
Describe the principles and operation of spring mechanisms, pulley blocks and differentials
Describe the principles and operation of chain, belt and disc drives and universal joints
Describe the principles and operation of clutch and coupling mechanisms
Describe the principles and operation of braking mechanisms
Describe the necessity for proper alignment and fit of mechanical devices
Describe the necessity for proper balance of system components
Describe proper component matching (e.g., sheave sets, gear sets)

Competency: Use bearings

Competency Builders:

Define bearing
Identify types of bearings and their applications
Identify installation method
Install bearings
Maintain bearings (e.g., lubrication)
Remove bearings
Identify bearing failure modes

Competency: Use seals

Competency Builders:

Define seal
Identify types of seals and their applications
Identify installation method
Install seals
Maintain seals
Remove seals
Identify failure modes

Competency: Use gears

Competency Builders:

Define gears
Identify types of gears, their materials, and their applications
Identify installation method
Install gears
Maintain gears (e.g., lubrication)
Remove gears
Identify failure modes

Competency: Use sheaves

Competency Builders:

Define sheaves
Identify types, tolerances, and materials of sheaves and their applications
Identify installation method
Install sheaves
Maintain sheaves
Remove sheaves
Identify failure modes

Competency: Use belts and pulleys

Competency Builders:

Define belts and pulleys
Identify types of belts and pulleys and their applications
Identify installation method
Install belts and pulleys
Maintain belts and pulleys
Remove belts and pulleys
Identify failure modes

Competency: Use sprockets and chains

Competency Builders:

Define sprockets and chains
Identify types of sprockets and chains and their applications
Identify installation method
Install sprockets and chains
Maintain sprockets and chains
Remove sprockets and chains
Identify failure modes

Competency: Use cams and levers

Competency Builders:

Define cams and levers
Identify types of cams and levers and their applications
Identify installation method
Install cams and levers
Maintain cams and levers
Remove cams and levers
Identify failure modes

Competency: Use clutches and brakes

Competency Builders:

Define clutches and brakes
Identify types of clutches and brakes and their applications
Identify installation
Install clutches and brakes
Maintain clutches and brakes
Remove clutches and brakes
Identify failure modes

Competency: Install drive components

Competency Builders:

Identify types of couplings and their applications
Install solid coupling
Install jaw coupling
Install molded rubber coupling
Install chain type coupling
Install a clutch
Install brakes
Align bearings, bushing, and cams
Install V-belts and adjust tensions
Install a V-belt and manually adjustable sheaves
Adjust a V-belt and manually adjustable sheaves
Install a V-belt with spring loaded adjustable sheaves
Explain the purposes and advantages of a chain drive system
Explain the function of speed reducers
Explain the function of gears and variable speed reducers
Install shafts
Align shafts
Mount drive sprockets and chains
Mount sheaves and pulleys
Mount gears on open gear drives
Align gears on open gear drives
Install a mechanical clutch system
Install adjustable speed drives
Troubleshoot adjustable speed drives
Explain the operation of fluid couplings
Install fluid couplings
Install torque converters
Perform preventive maintenance on drive components
Inspect completed work
Describe types of fit and tolerances
Explain importance of balance

Competency: **Describe the operation of mechanisms, linkages and levers**

Competency Builders:

Describe class one, two, three, and compound levers
Describe the principles and operation of rocker arm and bell crank linkages and combined mechanisms
Describe the principles and operation of four-bar mechanisms (crank, rocker, and double rocker)
Describe the principles and operation of drag link and intermediate mechanisms
Describe the principles and operation of four-bar variations
Describe the principles and operation of cam mechanisms
Describe the principles and operation of pivoted follower mechanisms
Describe the principles and operation of toggle, quick return, and ratchet mechanisms
Describe the principles and operation of geneva mechanisms

Competency: **Apply knowledge of lubricants**

Competency Builders:

Explain the function of lubricants
Explain the properties of oil lubricants and factors determining the selection of lubricants
Identify types and functions of lubricant additives
Describe types of circulating oils and their purposes
Describe lubricating systems, including the charts and methods used
Demonstrate proper grease application
Demonstrate proper lubricant storage and handling
Lubricate a piece of industrial equipment
Identify specified lubricant or equivalent
Explain lubricant recovery and disposal
Explain use of oil analysis reports

Unit: Electromechanical Technology

Competency: **Interpret electromechanical drawings**

Competency Builders:

Identify types of drawings and their applications
Transfer measurements
Explain the use of auxiliary views, revolutions, and sectional views
Describe dimensioning practices and techniques on drawings
Interpret mechanical/electronic production and assembly drawings

Competency: **Describe the operation of electronic sensors and transducers**

Competency Builders:

Explain temperature transducers operation
Explain stress and strain transducers operation
Explain magnetic transducers operation
Explain liquid and fluid flow transducers operation
Explain fiber optic system operation

Competency: **Demonstrate proficiency in transducers (sensors) and instrumentation**

Competency Builders:

Describe characteristics associated with transducers and instrumentation
Describe the principles and operations of various types of transducers (e.g., thermal, shock/vibration, acceleration, positional, pressure, flow, optical, gas and humidity)
Demonstrate the use of various transducers (e.g., thermal, shock/vibration, acceleration, positional, pressure, flow, optical, gas and humidity)
Troubleshoot transducers
Differentiate among thermocouple types
Interpret specifications of temperature sensors (e.g., thermocouples, thermistors, resistance temperature devices)
Interpret specification of pressure sensors (e.g., strain gage, piezzo electric/piezzo resistive) to electrical circuits
Interpret specifications of flow sensors (e.g., orifice flow meter, turbine meter, mass flow meters)
Interpret specifications of speed or position sensor (e.g., tachometer, resolver encoder, linear voltage differential transformer (LVDT)
Interpret specifications of controllers, indicators, and recorders (e.g., process controllers, programmable logic controllers with interfaces, R-chart recorders, dataloggers/indicators)
Interpret specifications of final control elements (i.e., silicon controlled rectifiers (SCR), power controllers, motor drives, actuators/robots)
Describe application circuits
Calculate specification of proximity sensors
Calculate specifications of infrared and photo-sensors
Explain use of proximity sensors
Explain use of photo electric sensors
Explain use of mechanically activated switches
Troubleshoot switch failure
Describe transducer control and measurement circuits
Demonstrate the use of control and measurement circuits
Troubleshoot control and measurement circuits

Competency: **Demonstrate proficiency in power distribution systems**

Competency Builders:

Describe power distribution systems
Describe poly-phase distribution systems
Describe single-phase distribution systems
Describe DC distribution systems
Describe delta distribution systems
Describe wye distribution systems
Describe medium-voltage distribution systems (less than 600v)
Troubleshoot poly-phase distribution systems
Troubleshoot single-phase distribution systems
Troubleshoot DC distribution systems
Troubleshoot delta distribution systems
Troubleshoot wye distribution systems
Troubleshoot medium-voltage distribution systems

Competency: **Demonstrate proficiency in power distribution equipment**

Competency Builders:

Describe power transformers
Describe power capacitors
Describe power oil switches and cutouts
Describe application of NEMA or IEC controls
Describe different types of enclosures for controls
Describe current transformers
Describe potential transformers
Describe medium-voltage circuits breakers and fuses
Use medium-voltage safety equipment
Troubleshoot power transformers
Troubleshoot power capacitors
Troubleshoot power oil switches and cutouts
Troubleshoot current transformers
Troubleshoot potential transformers
Troubleshoot medium-voltage circuit breakers and fuses

Competency: Demonstrate proficiency in motors and motor control

Competency Builders:

Test solid state components with ohmmeter
Test solid state DC motor control circuits
Test solid state AC motor control circuits
Calibrate or recalibrate equipment
Identify SCR and TRIAC AC control circuits
Explain how load is connected to 3-phase wye configured AC generator
Identify wye connected and delta connected 3-phase motors
Explain revolving fields in AC motors
Describe operation of common AC motors
Describe operation of variable frequency AC drives
Define advantages and disadvantages of common DC motors
Explain how motor load affects speed regulation
Describe operation of stepper motors
Describe speed control of various types of motor drives using sensors
Identify defective motors
Describe regenerative dynamic breaking
Describe operation of various feedback loops

Competency: Apply quality control techniques

Competency Builders:

Perform preventive maintenance
Perform predictive maintenance
Apply statistical process control (SPC)
Recalibrate equipment
Apply problem-solving tools and techniques

Competency: **Apply electromechanical maintenance management practices**

Competency Builders:

Keep maintenance records
Complete work order
Complete internal requisition
Complete external requisition
Explain planned maintenance
Explain breakdown maintenance
Explain predictive maintenance
Establish maintenance schedules
Explain reasons for keeping maintenance records
Explain reasons for keeping cost records
Analyze system failure
Make minor adjustments/repairs
Coordinate maintenance service
Make new/replacement equipment recommendations
Interpret bill of materials for allocation, stocking, and raw material information
Analyze use of bill of materials for workplace decision making

Unit: Hydraulics and Pneumatics

Competency: Describe fluid flow concepts

Competency Builders:

Explain Pascal's Law
Explain Boyle's Law
Explain Bernoulli's Principle
Describe flow velocity
Explain how heat and pressure relate to power and transmission
Describe physical and chemical properties of a fluid
Describe fluids in motion in closed conductors
Describe continuity of mass flow
Identify types of fluids
Identify properties of fluids
Identify English and metric units of measurement for pressure, density, and viscosity

Competency: Describe energy considerations

Competency Builders:

Differentiate work and power
Differentiate potential and kinetic energy
Explain energy conservation concept
Explain hydraulic horsepower
Explain work of compression in compressible fluids

Competency: Describe system losses

Competency Builders:

Differentiate turbulent and laminar flow
Explain friction factor
Explain pressure losses
Identify potential system losses (e.g., leaks, wear, component sizing, heat, dirt)

Competency: Describe hydrostatics

Competency Builders:

Explain pressure, density, and viscosity
Explain buoyancy
Explain equilibrium

Competency: Calculate energy

Competency Builders:

Apply Pascal's Law
Apply Bernoulli's Principle
Apply Boyle's Law
Calculate work and power
Calculate potential and kinetic energy
Calculate hydraulic horsepower
Calculate flow velocity and pressure
Calculate pressure losses
Calculate laminar flow
Calculate pump capacity
Calculate system requirements

Competency: Design basic hydraulic/pneumatic system

Competency Builders:

Use common symbols
Create circuit diagrams (i.e., schematics)
Diagram closed-loop hydraulic system
Diagram an air supply system

Competency: Describe component operation

Competency Builders:

Identify functions and operation of hydraulic components
Identify functions and operation of pneumatic components
Explain application(s) of different materials (e.g., plastic, copper)

Competency: Interpret hydraulic and pneumatic schematics

Competency Builders:

Identify common symbols
Sketch circuit diagrams (i.e., schematics)
Interpret circuit diagrams (i.e. schematics)
Sketch circuit analysis
Diagram an air supply system

Competency: Troubleshoot hydraulic and pneumatic circuits

Competency Builders:

Analyze hydraulic circuits
Troubleshoot hydraulic circuits
Analyze pneumatic circuits
Troubleshoot pneumatic circuits

Competency: Perform pump maintenance and repair

Competency Builders:

Identify types and operating features of pumps
Identify pump capacity and system requirements
Explain packing and seal requirements
Explain operating principles of pumps (e.g., centrifugal, propeller and turbine rotary, metering)
Perform pump maintenance
Disassemble a pump
Reassemble a pump

Competency: **Maintain piping and accessories for high and low pressure fluid power systems**

Competency Builders:

Identify components of a piping system
Explain maintenance features of both metallic and non-metallic piping systems
Explain types of values and their operation and maintenance
Explain use and maintenance of strainers, filters, and traps in piping systems
Join common fittings
Join metallic pipe
Join plastic pipe
Join copper and steel tubing
Bend copper and steel tubing
Cut copper and steel tubing
Flare tubing

Competency: **Maintain hydraulic system components**

Competency Builders:

Install a contaminant removal system
Maintain a contaminant removal system
Explain operation and use of heat exchanges
Identify reservoir requirements
Compute hose requirements
Install hydraulic lines
Select control valves and servo-type valves
Install control valves and servo-type valves

Competency: Troubleshoot hydraulic systems

Competency Builders:

Interpret hydraulic schematic
Identify causes of failure modes
Connect electrically controlled valves
Explain hydraulic system troubleshooting techniques
Repair or replace hydraulic valves
Repair or replace hydraulic cylinders
Repair or replace hydraulic pumps and motors
Install hydraulic components

Competency: Describe reciprocating and rotary air compressors

Competency Builders:

Explain relationship of force, weight, mass, and density in pneumatic system
Explain operation of reciprocating compressors
Explain operation of rotary compressors
Explain primary and secondary air treatment (e.g., air dryers, lubricating systems)
Explain operation of compressor valves, cylinders, and motors

Competency: **Maintain pneumatic systems**

Competency Builders:

Install pneumatic system components
Explain pneumatic system maintenance techniques
Explain pneumatic system troubleshooting procedures
Isolate faults in air compressors
Repair or replace air compressors
Isolate faults in control valves
Repair or replace control valves
Isolate faults in air motors
Repair or replace air motors
Isolate faults in air dryers
Repair or replace air dryers
Maintain proportioning and servo valves

Competency: **Troubleshoot pneumatic systems**

Competency Builders:

Interpret pneumatic schematic
Diagram an air supply system
Install pneumatic system components
Explain pneumatic system troubleshooting procedures
Troubleshoot air compressors
Troubleshoot pneumatic control valves
Troubleshoot air motors
Troubleshoot air dryers

Competency: Maintain vacuum systems

Competency Builders:

Describe characteristics associated with vacuum systems and sub atmospheric pressure
Describe the principles and operation of vacuum gauges
Demonstrate use of vacuum gauges
Repair or replace vacuum gauges
Describe the principles and operation of vacuum pumps
Demonstrate use of vacuum pumps
Repair or replace vacuum pumps
Describe the principles and operation of vacuum controls
Demonstrate use of vacuum controls
Repair or replace vacuum controls

Unit: Industrial Manufacturing Technology

Competency: Describe industrial manufacturing process

Competency Builders:

Demonstrate use and maintenance of personal protective equipment
Explain techniques of measuring motion, forces, voltage, current, power, distance, time and temperature
Explain mechanical and chemical properties of ferrous and non-ferrous metals
Explain industrial manufacturing process
Explain industrial use of non-metallic solids (e.g., ceramics, polymers), liquids, and gases
Develop flow chart and process sheets
Draft preventive maintenance and calibration procedures
Explain need for manufacturing documentation (e.g., ISO 9000)
Define quality process

Competency: Demonstrate knowledge of materials requirements planning

Competency Builders:

Define materials requirements planning
Explain importance of maintaining and controlling inventory (e.g., quantity, price, quality, minimal lot sizes, and timeliness)
Define master production schedule and bill of materials
Explain inventory carrying cost and economic order quantity
Describe the use of the computer in MRP
Calculate net requirements

Competency: Demonstrate knowledge of supply materials

Competency Builders:

Describe role of purchase requisitions
Describe role of material specifications
Describe role of quality parameters
Define supplier certification rating methods
Describe role of source inspector
Describe role of receiving

Competency: Demonstrate knowledge of plant layouts

Competency Builders:

Describe the importance of flexibility
Differentiate among product layout, process layout, fixed position layout, and cellular layout
Describe the type of production suited to each layout
Describe advantages and disadvantages of each layout

Competency: Demonstrate knowledge of material flow

Competency Builders:

Describe importance of flexibility
Differentiate straight-line, U-shaped, S-shaped, convoluted and comb patterns
Describe advantages and disadvantages of each pattern

Competency: Maintain quality control of materials handling

Competency Builders:

Maintain system for physical handling and movement of material in-process and in-storage
Monitor system of physical handling and movement of material in-process and in-storage
Maintain system for physical handling and movement of finished products
Monitor system of physical handling and movement of finished products
Write requests for deviation from specifications
Implement quality control and inspection standards and procedures
Write engineering change notices and rejection reports
Monitor reports of discrepancy or rejects during production process
Conduct quality tests under different environmental conditions

Competency: Demonstrate knowledge of post-production control

Competency Builders:

Explain importance of product protection, identification and storage
Describe methods of identifying products (e.g., labels, bar codes, radio frequency systems and magnetic strip systems)
Describe manual methods of storage and retrieval
Describe automated storage and retrieval systems (ASRS)
Describe automated guided vehicle moving systems (AGVS)

Competency: Analyze a manufacturing project

Competency Builders:

Explain the "how" of project selection
Explain the "how" of project implementation
Explain the "how" of project evaluation
Explain the "how" of planning continuing improvement
Explain the "how" of planning predictive maintenance

Unit: Programmable Logic Controllers (PLCs)

Competency: Differentiate among process controls

Competency Builders:

Describe characteristics associated with automatic controls
Define proportional control
Define integral control
Define derivative control
Describe advantages of using proportional, integral or derivative control
Describe disadvantages of using proportional, integral or derivative control

Competency: Explain basic operation of PLCs

Competency Builders:

Describe basic applications of PLCs
Identify program symbols and language functions
Describe function of block transfers
Describe operation of timers, counters, and sequences
Describe operation of analog I/O modules
Describe operation of servo motion control
Describe the principles and operation of PLCs

Competency: Demonstrate use of PLCs

Competency Builders:

Draw block diagram of a PLC
Define individual blocks of a PLC
Use operator's and/or manufacturer's manual(s)
Translate relay logic to logic for a PLC
Use function of block transfers
Operate timers, counters and sequencers
Operate analog I/O modules
Operate servo motion control
Install a PLC
Connect controller to sensors
Describe test procedures for new installation of a PLC
Troubleshoot hardware faults on a PLCs
Use safety interlock
Describe use of (Graphic Programmable Panel) GPP
Write a statement and ladder logic program
Document a statement and ladder logic program
Use a PLC program
Troubleshoot a program for a PLC
Repair a program for a PLC

Competency: Apply robot fundamentals

Competency Builders:

Describe the operation of robotic work cells
Operate robotic work cells
Troubleshoot robotic work cells
Repair robotic work cells
Classify robots according to industry criteria
Identify robot power drive types
Describe positioning in terms of axis, actuators and coordinate system
Identify types of control systems and sensors
Apply different methods of programming (e.g., teach, off-line)
Write simple programs to exercise robot functions
Join programs to perform full function
Identify principles of robot safety
Describe operation of various sensors used in robot control
Interface sensors to robot
Interface robots
Define open loop and closed loop control
Design a simple automated system to perform manufacturing operation
Identify operation of end-effectors

TECH PREP

"GET SERIOUS . . . ABOUT SUCCESS"

Mechanical Technician

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—NOTICE—

Each Tech-Prep Competency Profile developed should respond to the labor market demands of your Tech Prep Consortium. Therefore, the following pages should be examined carefully before being selected for use in TCP Part I. **[See "The TCP Process" for more information.]** For example, in some cases the number of units far exceeds the amount of content that can be covered within a 4 + 2 TPAD Program. All the units listed in this section will not necessarily apply to your situation, nor will all the competencies within each unit be appropriate. Note that several units appear within each specific occupation and would need to only appear once if you are compiling a cluster of occupations. **[See "TCP Matrix" and "How to Use the TCP Binder" for more information.]**

Unit: Communications Literacy

NOTE: This content was extracted from the 9-12 cluster of Ohio's Model Language Arts Program. Due to statewide initiatives other than Tech Prep, this literacy unit was not altered to meet competency-based criteria. Each literacy unit forms a critical link between academic teachers and members of business, industry, and labor. [See "The TCP Process" for more information.]

Subunit: Reading—Structure
Competencies:

RS1 Exhibit knowledge of language structure
RS2 Recognize that there may be more than one interpretation of reading selections
RS3 Recognize various literary devices
RS4 Recognize and discuss literary elements
RS5 Develop and use an increasingly sophisticated vocabulary gained through context
RS6 Apply knowledge of language structure to reading
RS7 Explain why there may be more than one interpretation of reading selections
RS8 Recognize effect of literacy devices on meaning
RS9 Analyze author's use of literary elements
RS10 Recognize relationship of structure to meaning
RS11 Describe various interpretations and meaning levels in reading selections
RS12 Characterize author's use of literary devices
RS13 Characterize use of literary techniques
RS14 Critique a variety of literature with regard to plot, dialogue, theme, setting, and characterization
RS15 Apply an expanding vocabulary gained through reading
RS16 Explain various interpretations and meaning levels in reading selections
RS17 Analyze use of literary techniques (e.g., extended metaphor, simile, personification, hyperbole, pun, alliteration)
RS18 Understand use of literary devices (e.g., irony, satire, allegory, onomatopoeia)
RS19 Analyze and synthesize pieces of literature with regard to plot, dialogue, theme, setting, and characterization

Subunit: Reading—Meaning Construction
Competencies:

RM1	Demonstrate ability to recognize appropriate pre-reading strategies
RM2	Describe effectiveness of a reading selection
RM3	Read to clarify personal thinking and knowledge
RM4	Support interpretation of text by locating and citing specific information
RM5	Develop personal response to a variety of literary works
RM6	Recognize diverse literary interpretations
RM7	Engage in self-selected reading activities
RM8	Confirm and extend meaning in reading by researching new concepts and facts
RM9	Self-monitor and apply corrective strategies when communication has been interrupted or lost
RM10	Use features of literary genres to extend meaning
RM11	Assess effectiveness of a selection read
RM12	Use reading as a possible problem-solving strategy to clarify personal thinking and knowledge
RM13	Use knowledge of semantic elements (e.g., figurative language, denotation, connotation, dialect) to clarify meaning when reading
RM14	Predict, recognize, interpret. and analyze themes based on familiarity with author's work
RM15	Compare and contrast literary genres
RM16	Assess validity and quality of selection read
RM17	Clarify meaning when reading
RM18	Compare personal reaction to critical assessment of a literary selection
RM19	Assess validity of diverse literary interpretations
RM20	Use reference books to find, evaluate, and synthesize information
RM21	Identify tone of a literary work
RM22	Critique validity of diverse literary interpretations
RM23	Integrate personal reaction to and critical assessment of a literary selection

Subunit: Reading—Application
Competencies:

RA1	Select and read material for personal enjoyment and information
RA2	Read a variety of complete, unabridged works
RA3	Employ various reading strategies according to purpose
RA4	Participate in selection of books, materials, and topics for literature study groups
RA5	Develop and apply knowledge of the interrelationship of concepts
RA6	Read selections from a variety of styles and formats, recognizing that style and format influence meaning
RA7	Extend value of reading, writing, speaking, viewing, and listening by pursuing, through reading, new concepts and interests developed as a result of these activities
RA8 of	Read extensively from a particular author's work and explain elements author's style

Subunit: Reading—Multidisciplinary
Competencies:

RM1	Connect themes and ideas across disciplines through literature
RM2	Read to facilitate learning across curriculum
RM3	Read to develop awareness of human rights and freedom
RM4	Participate actively in a community of learners
RM5	Recognize and explain interaction between literature and various cultural domains (e.g., social technological, political, economic)
RM6	Explore and analyze a variety of cultural elements, attitudes, beliefs, and value structures by men and women of many racial, ethnic, and cultural groups
RM7	Value thinking and language of others
RM8	Relate literature to historical period about which or in which it was written
RM9	Read to facilitate content learning

Subunit: Writing—Structure
Competencies:

WS1	Develop and expand a repertoire of organizational strategies (e.g., narration, comparison/contrast, and description) through a practice and discussion
WS2	Clarify word choice according to audience, topic, and purpose
WS3	Locate and correct errors in usage, spelling, and mechanics using a variety of resources
WS4	Recognize information gained from primary and secondary sources
WS5	Develop writing which contains ordered, related, well-developed paragraphs with sentences of varied lengths and patterns
WS6	Use information from a variety of sources to develop an integrated piece of writing
WS7	Evaluate and revise writing to focus on such things as audience, tone, and purpose
WS8	Recognize differences between documentation and reference list styles
WS9	Develop extended pieces of writing which contain ordered, related, well-developed paragraphs with sentences of varied lengths and patterns
WS10	Select from a repertoire of organization strategies a pattern appropriate to a topic
WS11	Synthesize information from a variety of sources
WS12	Refine word choice and tone according to audience, situation, and purpose
WS13	Appropriately cite information gained from primary and secondary sources
WS14	Use style manuals or software to prepare documentation and reference lists
WS15	Develop effectively organized pieces of expository writing containing strong voice, clear thesis, and well-developed ideas
WS16	Identify organization patterns appropriate to writing topic
WS17	Respond to others' suggested revisions to a writing piece

Subunit: Writing—Meaning Construction
Competencies:

WM1	Demonstrate knowledge of the recursive nature of the writing process by applying it appropriately to various topics, situations, and audiences
WM2	Develop criteria for writing evaluation using scoring guides and peer/teacher assistance to clarify meaning
WM3	Respond to others' suggested revisions to a piece of writing
WM4	Use word processing, graphics, and publishing aids to construct meaning in writing
WM5	Engage in self-initiated writing activities
WM6	Incorporate personal criteria with generally accepted standards for writing evaluation
WM7	Evaluate, analyze, and synthesize information for writing
WM8	Evaluate own writing using personal and established scoring criteria
WM9	Assess personal/peer revisions to a writing piece
WM10	Recognize and refine personal writing styles

Subunit: Writing—Application
Competencies:

WA1	Apply appropriate writing techniques suitable for varied writing tasks
WA2	Use sentence-combining techniques to improve syntactic fluency and maturity
WA3	Write in response to prompted and self-selected topics in practical, persuasive, descriptive, narrative, and expository domains
WA4	Develop personal voice in writing
WA5	Consider audience and purpose for writing
WA6	Develop criteria for selection and potential development of topic
WA7	Write in a journal or learning log to clarify personal thinking and knowledge
WA8	Apply an expanding vocabulary gained through writing
WA9	Make judicious use of reference sources (e.g., dictionary, thesaurus, on-lien data base, encyclopedia)
WA10	Demonstrate, an appreciation for aesthetically pleasing language through word choice and style
WA11	Apply revising and editing strategies needed for writing task
WA12	Vary sentence lengths and patterns
WA13	Refine personal voice in writing
WA14	Vary styles and formats for intended purpose and audience
WA15	Apply criteria for selection and development of topic
WA16	Participate in peer review of writing in progress
WA17	Use transitions between sentences, ideas, and paragraphs in writing
WA18	Revise and edit papers extensively in preparation for presentation/publication
WA19	Develop a variety of genres
WA20	Focus writing and tone on such elements as audience, situation, and purpose
WA21	Develop topic fully and appropriately
WA22	Use writing process to clarify personal thinking and knowledge
WA23	Apply appropriate recursive writing process as suggested by writing task and writer's process
WA24	Develop an extended piece of writing
WA25	Revise writing and tone to assure focus on such elements as audience, situation, and purpose
WA26	Use writing process to write reflectively

Subunit: Writing—Multidisciplinary

Competencies:

WM1	Use writing process for learning across curriculum
WM2	Use writing process to demonstrate knowledge of need for human rights and freedom
WM3	Value and apply collaborative skills in writing process
WM4	Write in response to reading, speaking, viewing, and listening
WM5	Use multidisciplinary resources in writing projects
WM6	Use writing process to facilitate learning across curriculum
WM7	Recognize value of and engage in collaboration in writing process
WM8	Use communication processes to develop a published writing piece in collaboration with others
WM9	Record experiences and observations related to content learning
WM10	Apply collaborative skills in writing process
WM11	Write collaboratively with peers
WM12	Use cross-disciplinary resources in writing projects

Subunit: Listening/Visual Literacy—Structure

Competencies:

LS1	Listen to and view a wide variety of genres
LS2	Become aware of an author's style through listening and viewing a variety of works
LS3	Recognize correct and appropriate grammar, diction, and syntax
LS4	Expand vocabulary through listening to and viewing varied media
LS5	Recognize beauty of language
LS6	Enhance recognition of an author's style through listening and viewing a variety of works
LS7	Recognize use and misuse of language in media
LS8	Refine knowledge of style through listening and viewing multiple works by the same author
LS9	Expand and refine grammar, diction, and syntax through listening
LS10	Compare authors' styles through viewing and listening to their works
LS11	Expand knowledge of complex grammar, diction, and syntax issues

Subunit: Listening/Visual Literacy—Meaning Construction
Competencies:

LM1 Develop critical thinking skills necessary to evaluate media and assess oral presentations
LM2 Compare new oral texts to past experiences and knowledge in order to enhance comprehension
LM3 Recognize how rhythmic patterns, silence, and cadences enhance quality of speech and literature
LM4 Focus listening and viewing on themes and/or plots
LM5 Gather information from listening and viewing experiences to enhance research
LM6 Use critical thinking skills to evaluate media and oral presentations
LM7 Use prior knowledge and experiences to facilitate comprehension of new oral texts
LM8 Identify rhythmic and time patterns in speech and literature
LM9 Identify and analyze themes and/or plots when listening and viewing
LM10 Use information gathered from listening and viewing experiences to expand research
LM11 Enhance use of critical thinking skills to evaluate media and oral presentations
LM12 Consider prior knowledge and experiences when attempting to understand the meaning of new texts
LM13 Appreciate rhythmic and time patterns of speech and literature
LM14 Select viewing and listening materials to support written text
LM15 Evaluate media and oral presentations analytically and critically
LM16 Organize prior knowledge and experiences to comprehend new texts
LM17 Organize and use viewing and listening materials to support written text

Subunit: Listening/Visual Literacy—Application
Competencies:

LA1 Listen attentively during oral reading
LA2 Use media as stimuli for learning and thinking
LA3 Develop knowledge of structure through art, music, and literature
LA4 Use electronic media to enhance and highlight language learning
LA5 Listen and view for entertainment and enjoyment
LA6 Use technology and other media as means of expressing ideas

Subunit: Listening/Visual Literacy—Multidisciplinary

Competencies:

LM1 Facilitate learning across curriculum through critical listening and viewing
LM2 Engage in individual, small-group, and whole-group listening and viewing activities
LM3 Develop language arts (e.g., viewing, listening) projects collaboratively
LM4 Investigate language and cultural differences through listening and viewing activities
LM5 Participate in a community of learners through productive listening

Subunit: Oral Communication—Structure

Competencies:

OS1 Refine oral communication skills
OS2 Demonstrate knowledge of grammar, usage, and syntax when presenting
OS3 Select topics and vocabulary suitable to audience
OS4 Organize notes and ideas for speaking
OS5 Use language imaginatively
OS6 Modulate voice to meaning when interpreting literature orally
OS7 Organize notes and ideas for formal, semiformal and informal presentations of information
OS8 Refine speaking techniques for formal, semiformal, and informal settings
OS9 Develop repertoire of organizational strategies for presenting information orally
OS10 Expand vocabulary to fit topic
OS11 Select topics suitable to audience, situation, and purpose
OS12 Select appropriate strategies when organizing notes and ideas for speaking

Subunit: Oral Communications—Meaning Construction
Competencies:

OM1 Make connections between prior knowledge and new information for oral presentations
OM2 Participate in informal speaking activities
OM3 Use interviewing techniques to gather information
OM4 Communicate orally to entertain and to inform
OM5 Participate in group communication activities
OM6 Take and organize notes when preparing speech/presentation
OM7 Interpret texts orally to illustrate meaning
OM8 Respond to needs of various audiences
OM9 Gather and assess information for speaking
OM10 Communicate orally to inform and persuade
OM11 Prepare and deliver formal speech/presentation
OM12 Participate in a variety of oral interpretations
OM13 Assess needs of audience and adjust language and presentation according to their knowledge
OM14 Analyze and synthesize information for speaking
OM15 Describe effectiveness of literary selection
OM16 Describe topic or idea in order to clarify personal/audience thinking
OM17 Analyze and synthesize information gathered from a variety of sources for speaking
OM18 Describe validity and/or quality of a literary selection and justify selection
OM19 Interpret orally a variety of literature
OM20 Describe topic or idea to clarify meaning for others

Subunit: Oral Communication—Application
Competencies:

OA1 Become proficient at using interviewing techniques
OA2 Give an oral interpretation for a specific audience
OA3 Develop and apply oral communication skills for cooperative/collaborative learning
OA4 Use oral communication for a variety of purposes and audiences (e.g., negotiations, book reviews, rationales)
OA5 Develop and apply decision-making strategies
OA6 Practice interviewing techniques
OA7 Apply interviewing techniques to purposeful interviews
OA8 Focus oral interpretation on a specific audience

Subunit: Oral Communications—Multidisciplinary

Competencies:

OM1	Value thinking and language of others
OM2	Develop oral projects collaboratively
OM3	Be involved in individual, small-group, and whole-group language activities
OM4	Participate actively in a community of learners
OM5	Investigate language and cultural differences through oral language activities

Unit: Mathematics Literacy

NOTE: This content was extracted from the 9-12 cluster of Ohio's Model Mathematics Program. Due to statewide initiatives other than Tech Prep, this literacy unit was not altered to meet competency-based criteria. Each literacy unit forms a critical link between academic teachers and members of business, industry, and labor. [See "The TCP Process" for more information.]

Subunit: Numbers and Number Relations
Competencies:

NR1 Compare, order, and determine equivalence of real numbers
NR2 Estimate answers, compute, and solve problems involving real numbers
NR3 Compare and contrast real number system, rational number system, and whole number system
NR4 Extend knowledge to complex number system and develop facility with its operation

Subunit: Measurement
Competencies:

M1 Estimate and use measurements
M2 Understand need for measurement and probability that any measurement is accurate to some designated specification
M3 Understand and apply measurements related to power and work
M4 Understand and apply measurement concepts of distance-rate-time problems and acceleration problems
M5 Use real experiments to investigate elasticity, heat, sound, electricity, magnetism, light, acceleration, velocity, energy, and gravity
M6 Use real-world problem situations involving mass and weight
M7 Use real-world problem situations involving simple harmonic motion
M8 Establish ratios with and without common units
M9 Construct and interpret maps, tables, charts, and graphs as they relate to real-world mathematics
M10 Understand and solve rate-change problems
M11 Understand and solve right triangle relationships as they relate to measurement, specifically to Pythagorean theorem
M12 Graph and interpret ordered pairs
M13 Compute total sales from a variety of items
M14 Comprehend and compute rates of growth or decay
M15 Comprehend, compute, and interpret real problems involving annuities

Subunit: Measurement (continued)

Competencies:

M16 Develop an ability to identify real problems and provide possible solutions

M17 Express and apply different types of measurement scales

M18 Identify area and volume

Subunit: Estimation and Mental Computation

Competencies:

E1 Use estimation to eliminate choices in multiple-choice tests

E2 Use estimation to determine reasonableness of problem situations in a wide variety of applications

E3 Estimate shape of graphs of various functions and algebraic expressions

E4 Use mental computation when computer and calculator are inappropriate

Subunit: Data Analysis and Probability

Competencies:

D1 Organize data into tables, charts, and graphs

D2 Understand and apply measures of central tendency, variability, and correlation

D3 Use curve fitting to predict from data

D4 Use experimental or theoretical probability, as appropriate, to represent and solve problems involving uncertainty

D5 Use computer simulations and random number generators to estimate probabilities

D6 Test hypotheses using appropriate statistics

D7 Read, interpret, and use tables, charts, and graphs to identify patterns, note trends, draw conclusions, and make predictions

D8 Identify probabilities of events involving unbiased objects

D9 Use sampling and recognize its role in statistical claims

D10 Design a statistical experiment to study problem, conduct experiment, and interpret and communicate outcomes

D11 Describe normal curve in general terms and use its properties

D12 Create and interpret discrete probability distributions

D13 Understand concept of random variable

D14 Apply concept of random variable to generate and interpret probability distributions, including binomial, uniform, and chi square

Subunit: Algebra
Competencies:

A1	Describe problem situations by using and relating numerical, symbolic, and graphical representations
A2	Use language and notation of functions in symbolic and graphing settings
A3	Recognize and use equivalent zeros of a function, roots and the solution of an equation in terms of graphical and symbolic representations
A4	Describe and use logic of equivalence in working with equations, inequalities, and functions
A5	Develop graphical techniques of solution for problem situations involving functions
A6	Explore and describe characterizing features of functions
A7	Make arguments and proofs in algebraic settings
A8	Factor difference of two squares
A9	Identify slope, midpoint, and distance
A10	Explore and combine rational functions
A11	Explore factoring techniques
A12	Solve quadratic equations by factoring and formula
A13	Set up and solve linear equations
A14	Solve systems of linear equations with two variables
A15	Describe geometric situations and phenomena using variables, equations, and functions
A16	Describe measures of central tendency, mean, median, mode, and variance algebraically and graphically
A17	Represent inequalities on number line and in coordinate plane
A18	Use coordinate arguments in making geometric proofs
A19	Symbolize transformations of figures and graphs
A20	Explore geometric basis for functions of trigonometry
A21	Graph linear functions
A22	Develop and use vectors to represent direction and magnitude including operations
A23	Use polar and parametric equations to describe, graph, and solve problem situations
A24	Represent sequences and series as functions both algebraically and graphically
A25	Explore recursive functions and procedures using spreadsheets, other computer utilities, and appropriate notions
A26	Describe and solve algebraic situations with matrices
A27	Describe and use inverse relationship between functions including exponential and logarithmic

Subunit: Algebra (continued)
Competencies:

A28 Analyze and describe errors and error sources that can be made when using computers and calculators to solve problems
A29 Decide whether problem situation is best solved using computer, calculator, paper and pencil, or mental arithmetic/estimation techniques
A30 Explore relationships between complex numbers and vectors
A31 Make arguments concerning limits, convergence and divergence in context involving sequences, series, and other types of functions
A32 Represent transformations in plane with matrices
A33 Contrast and compare algebra's of rational, real, and complex numbers with characteristics of a matrix algebra system
A34 Construct polynomial approximations of a function over specified intervals of convergence
A35 Examine complex numbers as zeros of functions
A36 Translate verbal statements into symbolic language
A37 Simplify algebraic expressions
A38 Use laws and exponents (including scientific notation)
A39 Expand and extend idea of vectors and linear algebra to higher dimensional situations
A40 Use the idea of independent basis elements for a vector space and associated fundamental concepts of finite dimensional linear algebra
A41 Develop and communicate arguments about limit situations
A42 Use matrices to describe and apply transformations
A43 Develop and use polar and parametric equations to represent problem situations
A44 Explore proofs by mathematical induction

Subunit: Geometry
Competencies:

G1	Create and interpret drawings of three-dimensional objects
G2	Represent problem situations with geometric models and apply properties of figures
G3	Apply Pythagorean theorem
G4	Demonstrate knowledge of angles and parallel and perpendicular lines
G5	Explore inductive and deductive reasoning through applications to various subject areas
G6	Translate between synthetic and coordinate representations
G7	Identify congruent and similar figures using transformation with computer programs
G8	Deduce properties of figures using transformations and coordinates
G9	Use deductive reasoning
G10	Explore compass and straightedge constructions in context of geometric theorems
G11	Demonstrate knowledge of and ability to use proof
G12	Use variety of proof techniques (e.g., synthetic, transformational, and coordinate)
G13	Use variety of proof formats, including T-proof (i.e., two-column) and paragraph proof
G14	Explore different proof strategies
G15	Investigate different proofs of theorems
G16	Develop knowledge of an axiomatic system
G17	Apply transformations and coordinates in problem solving
G18	Represent problem situations with geometric models and apply properties of figures
G19	Deduce properties of figures using vectors
G20	Analyze properties of Euclidean transformations and relate translations to vectors
G21	Apply vectors in problem solving
G22	Develop further knowledge of axiomatic systems by investigating and comparing various geometry's

Subunit: Patterns, Relations, and Functions
Competencies:

P1 Model real-world phenomena with polynomial and exponential functions
P2 Explore relationship between zeros and intercepts of functions
P3 Translate among tables, algebraic expressions, and graphs of functions
P4 Use graphing calculator or computer to generate graph of a function
P5 Explore relationship between a linear function and its inverse
P6 Describe and use characteristics of polynomial functions in problem-solving situations
P7 Explore conic sections and graph using graphing calculator or computer
P8 Apply trigonometric functions to problem situations involving triangles
P9 Discover relationships between algebraic description, kind, and properties of conic
P10 Explore periodic real-world phenomena using sine and cosine functions
P11 Analyze effects of parameter changes on graphs
P12 Use graphing calculator or computer to graph functions
P13 Develop an knowledge of rational and transcendental functions
P14 Understand connections between trigonometric and circular functions
P15 Use circular functions to model periodic real-world functions
P16 Solve trigonometric equations and verify trigonometric identities
P17 Understand connections between trigonometric, exponential, and logarithmic functions and polar coordinates, complex numbers, and series
P18 Model real-world phenomena with a variety of functions
P19 Graph using polar coordinates
P20 Explore graphs in three dimensions
P21 Explore functions of several variables
P22 Explore recursive functions using spreadsheets and/or programming languages

Unit: Science Literacy

NOTE: This content was extracted from the 9-12 cluster of Ohio's Draft Model Science Program. Due to statewide initiatives other than Tech Prep, this literacy unit was not altered to meet competency-based criteria. Each literacy unit forms a critical link between academic teachers and members of business, industry, and labor. [See "The TCP Process" for more information.]

Subunit: Scientific Inquiry

Competencies:

Q1 Check the appropriateness and accuracy of measures and computations using various strategies (e.g., estimations, unit analysis, determination of significant figures)

Q2 Use ratios, proportions, and probabilities in appropriate problem situations

Q3 Translate information from and represent information in various forms with equal ease (e.g., tables, charts, graphs, diagrams, geometric figures)

Q4 Use existing algebraic formulas and create new ones in appropriate problem-solving situations

Q5 Estimate and justify probabilities of outcomes of familiar situations based on experimentation and other strategies

Q6 Invent apparatus and mechanical tools needed to perform unique tasks in various situations

Q7 Identify, compare, and contrast different modes of inquiry, habits of mind, and attitudes and dispositions

Q8 Design investigations that are safe and ethical (i.e., obtain consent and inform others of potential outcomes, risks and benefits, and show evidence of concern for human health and safety, concern for non-human species)

Q9 Make and read scale drawings, maps, models, and other representations to aid planning and understanding

Q10 Seek elaboration and justification of data and ideas, and reflect on alternative interpretations of the information

Q11 Use appropriate units for counts and measures

Q12 Create and use databases (electronic and other) to collect, organize, and verify data and observations

Q13 Design and conduct investigations with multiple variables

Q14 Communicate the results of investigations clearly in a variety of situations

Subunit: Scientific Inquiry (continued)
Competencies:

Q15 Examine relationships in nature, offer alternative explanations for the observations, and collect evidence that can be used to help judge among explanations

Q16 Trace the development (e.g., history, controversy, and ramifications) of various theories, focusing on supporting evidence and modification with new evidence

Q17 Select, invent, and use tools, including analog and digital instruments, to make and record direct measurements

Q18 Observe and document events and characteristics of complex systems

Q19 Explain the influence of perspective (e.g., spatial, temporal, and social) on observation and subsequent interpretations

Q20 Create multiple representations of the same data using a variety of symbols, descriptive languages, mathematical concepts, and graphic techniques

Q21 Generate testable hypotheses for observations of complex systems and interactions

Q22 Document potentially hazardous conditions and associated risks in selected homes and public areas

Q23 Participate in public debates, relying on documented and verified data to construct and represent a position on scientific issues

Q24 Construct and test models of physical, biological, social, and geological systems

Q25 Read, verify, debate, and, where necessary, refute research published in popular or technical journals of science (e.g., *Discover*, *Omni*, *Popular Mechanics*)

Q26 Explore discrepant events and develop and test explanations of what was observed

Q27 Conduct theory-based research using surveys, observational instruments, and other methods

Q28 Modify personal opinions, interpretations, explanations, and conclusions based on new information

Q29 Analyze error and develop explanations in various domains

Q30 Formulate taxonomic schemes based upon multivariate models that help to explain similarities and differences in form, distribution, behavior, survival, and origin of objects and organisms

Q31 Demonstrate various logical connections between related concepts (e.g., entropy, conservation of energy)

Q32 Account for discrepancies between theories and observations

Q33 Analyze the changes within a system when inputs, outputs, and interactions are altered

Subunit: Scientific Inquiry (continued)
Competencies:

Q34 Create, standardize, and document procedures

Q35 Determine the sources of significant disparities between the predicted and recorded results and change research procedures to minimize disparities

Q36 Research, locate, and propose applications for abstract patterns (e.g., fractals, Fibonacci sequences, string theory, orbitals)

Q37 Recognize and utilize classification systems for particles, elements, compounds, phenomena, organisms, and others for exploring and predicting properties and behaviors

Q38 Suggest and defend alternative experimental designs and data explanations (e.g., sampling, controls, safeguards)

Q39 Recognize and communicate differences between questions that can be investigated in a scientific way and those that rely on other ways of knowing

Q40 Draw conclusions based on the relationships among data analysis, experimental design, and possible models and theories

Q41 Suggest new questions as a result of reflection on and discussions about their own scientific investigations

Q42 Investigate, assess, and comment on strengths and weakness of the descriptive and predictive powers of science

Q43 Create new information from representations of data in a variety of forms (e.g., symbols, descriptive languages, graphic formats) utilizing a variety of techniques (e.g., interpolations, extrapolations, linear regressions, central tendencies, correlation's)

Subunit: Scientific Knowledge
Competencies:

K1 Investigate various types of dynamic equilibrium (e.g., biological, geological, mechanical, chemical)

K2 Investigate the relationship between the rates of energy exchange and the relative energy level of components with systems (e.g., tropic levels of ecosystems, osmosis, rate of heating and cooling, storms)

K3 Investigate patterns in the natural world (e.g., heredity, crystalline structures, population and resource distributions, diffraction, dispersion, polarization)

K4 Investigate models and theories that help to explain the interactions of components in systems (e.g., conservation of mass, energy, and momentum; food webs; natural selection; entropy; plate tectonics; chaos; relativity; social-psychology)

K5 Investigate degrees of kinship among organisms and groups of organisms

K6 Investigate the limits of the definition of life, and investigate organisms and physical systems that exist at or near these limits (e.g. viruses, quarks, black holes)

K7 Investigate estimates and measurements of a wide range of distances and rates of change

K8 Investigate the historical development of theories of change over time (e.g., natural selection, continental drift, the big bang, geologic change)

K9 Investigate physical and chemical changes in living and non-living systems (e.g., photosynthesis, weathering processes, glaciation, thermal effects of materials, energy cells)

K10 Investigate simulations of nuclear change (e.g., radioactivity, half life, carbon dating)

K11 Investigate conservation principles associated with physical, chemical, and nuclear changes

K12 Formulate descriptions of the impacts of various forms of mechanical and electromagnetic waves on various organisms on each other over time

K13 Formulate models and hypotheses for patterns in the natural world (e.g., earth structures, transportation systems, migrations, communications, constellations)

K14 Formulate explanations for the influences of objects and organisms on each other over time

K15 Formulate and interpret explanations for change phenomena (e.g., mass extinction's, stellar evolution, punctuated equilibrium, molecular synthesis)

Subunit: Scientific Knowledge (continued)
Competencies:

K16 Formulate and interpret explanations for the magnitudes of diversity at different periods of geologic time (e.g., mutation, global cataclysms, continental drift, competition, mass extinction's)

K17 Formulate interpretations of the structure, function, and diversity in a variety of organisms and physical systems (e.g., DNA and RNA variants, nucleons, interaction particles)

K18 Formulate understandings of geologic time (e.g., millennia, periods, epochs)

K19 Formulate an understanding of the historical development of the model of the universe

K20 Formulate explanations and representations of the production, transmission, and conservation of energy in biological and physical systems (e.g., weather, volcanism, earthquakes, electricity, magnetism, cellular respiration)

K21 Formulate models and hypotheses about patterns in the natural world (e.g., social behavior, molecular structure, energy transformation, entropy, randomness, aging, chaos, hormonal cycles)

K22 Formulate interpretations of the relationship between energy exchange and the interfaces between components within systems

K23a Formulate estimations for the range of energies within and between various phenomena (e.g., thermal, electromagnetic, thermonuclear, chemical, electrical)

K23b Formulate explanations for the historical development of descriptions of motions interactions and transformations of matter and energy (e.g., classical Newtonian mechanics, special and general relativity, chaos)

K24 Formulate models that can be used to describe fundamental molecular interactions in living and non-living systems (e.g., cell membranes, semiconductors).

K25 Formulate an understanding of the degree of relationship among organisms and objects based on molecular structure (e.g., proteins, nucleic acids)

K26 Formulate hypotheses and models that may account for observable events (e.g., electricity and magnetism, gravitation, atoms, bonding, chemical reactions, quantum effects, energy flow on biological systems, predator-prey relationships)

K27 Formulate models and hypotheses about change over time (e.g., natural selection, speciation, punctuated equilibrium, phyleytic gradualism, stellar evolution, plate tectonics, radioactive decay, quantum mechanical theory)

Subunit: Scientific Knowledge (continued)
Competencies:

K28 Formulate lists of limitations and propose refinements of standard classification systems (e.g., periodic table, IUPAC, Linnean, standard model)

K29 Formulate specific cases of limitations and possible exceptions of theories and principles regarding the interactions of moving objects and organisms (e.g., fluid flow in vessels, motion near the speed of light, Heisenberg uncertainty principle, meteorological prediction, local variation and diversity, predicting earthquakes, energy transport in cellular respiration)

K30 Formulate plans and contingencies that can be used to accommodate for changes to and stresses on systems (e.g., wildlife and habitat management, corrosion prevention, noise abatement, structure design)

K31 Formulate models of molecular, atomic, ionic, and subatomic structures and the physical and biological implications of these structures (e.g., genes, nucleons, quarks)

K32 Formulate estimates for a wide range of measurements and scales (e.g., angstroms to light years)

K33 Formulate and interpret representations of time from origin to present accounting for phenomena of scale (e.g., smoothness, punctuation's, chaos)

K34 Formulate interpretations of the historical development of various theories of possible causes of diversity among physical and biological phenomena (e.g., the works of Aristotle, Mendel, Darwin, McClintock)

K35 Formulate models and hypotheses that can be used to explain the interactions of components within technological and ecological systems

Subunit: Conditions for Learning Science
Competencies:

C1 Participate actively in dialogue about and resolution of community issues
C2 Assess information from various countries in the original language or translated form to ascertain the perspectives of many cultures
C3 Analyze the scientific ideas presented in science fiction stories and films
C4 Perform and repeat investigations to verify data, determine regularity, and reduce the impact of experimental error
C5 Present the results of investigations in a variety of forums
C6 Contribute to the decisions regarding topics for investigation
C7 Use various creative means to communicate interpretations of scientific ideas, concepts, phenomena, and events
C8 Consider the scientific thinking and language of others
C9 Individually and collaboratively produce clearly written representations of investigative results
C10 Fulfill responsibilities as part of a research group
C11 Select and utilize resources by various criteria (e.g., efficiency, effectiveness, health, safety) that are appropriate to the investigations being conducted by groups
C12 Present persuasive argument based on the scientific aspects of controversial issues
C13 Collect, store, retrieve, and manipulate information with available t technologies alleges that may range from hand processes up through computer applications
C14 Investigate social issues with a scientific perspective (e.g., human rights, wellness, economics, futurism, environmental ethics)
C15 Keep journals of observations and inferences made over an extended period of time and reflecting upon the impact of these recorded ideas on their thinking and actions
C16 Examine the intellect, perspectives, and ethics of notable scientists
C17 Collect and analyze observations made over extended periods of time and compare these to scientific theories
C18 Create presentations of scientific understandings using diverse modes of expressions
C19 Conduct formal scientific debates in the classroom
C20 Wonder about the likelihood of events that may occur by chance or coincidence
C21 Plan and conduct field trips and experiences for small and large groups
C22 Analyze the historical context which leads to and has lead to scientific t theories

Subunit: Conditions for Learning Science (continued)
Competencies:

C23 Seek information on topics of personal scientific interest from a variety of sources

C24 Conduct learner-developed investigations independently and collaboratively over periods of week and months

C25 Listen attentively and critically to presentations of scientific information made by others

C26 Conduct analyses of propaganda related to scientific issues

C27 Perform investigations that require observations over varying periods of time

C28 Experience scientific concepts as interpreted by other cultures through multimedia and local and global specialists

C29 Access appropriate technology to perform complicated, time-consuming tasks

C30 Relate historical accounts of science to the cultural context in which they were written

C31 Work as a contributing member of a collaborative research group

C32 Examine the influences of social and political structures and realities that contribute to inquiry about scientific issues

C33 Use technology (e.g., desktop publishing, teleconferencing, networking) to communicate scientific ideas

C34 Explore and analyze a variety of perspectives on science (e.g., works by men and women of many racial, ethnic, and cultural groups)

C35 Lead groups of learners of various ages in designing, planning, and conducting science activities

C36 Respect the scientific thinking of others and self

C37 Recognize and contrast different epistemologies

C38 Develop possible courses of action in response to scientific issues of local and global concern

C39 Determine the validity of research conclusions in relation to the design, performance, and results

C40 Develop multimedia presentations of group and individual research projects and investigations appropriate for a variety of audiences and forums

C41 Produce interesting and scientifically correct stories and present them using various modes of expression

C42 Reflect on the ideas and content found in their own journal records

C43 Examine ambiguous results and formulate explanations

C44 Recognize and synthesize the contributions to scientific thought of individuals from many cultures

Subunit: Conditions for Learning Science (continued)
Competencies:

C45 Construct models and simulations of the component structures and functions of living and non-living entities
C46 Lead multi-age groups in the examination of and planned resolution for scientific issues
C47 Recognize and choose members of research teams based upon the merit of their ideas and skills
C48 Construct a portfolio of products, documentation, and self-evaluations of his/her own abilities, skills, and experiences
C49 Synthesize scientific information from a variety of sources
C50 Evaluate and prioritize scientific issues based upon risk-benefit analyses
C51 Refining scientific skills from a variety of experiences

Subunit: Applications for Science Learning
Competencies:

A1 Answer student-determined questions by designing databases and drawing inferences from the analyses of the information in these data bases
A2 Make personal behavior decisions by interpreting information that has a scientific basis
A3 Propose courses of action that will validate and demonstrate personal understandings of scientific principles
A4 Guide other learners in their understanding of the interactions of technologies and society at various periods in time
A5 Promote and carry out practices that contribute to a sustainable environment
A6 Study and propose improvements in public services and systems in their community
A7 Choose consumer materials utilizing personal and environmental risk and benefit information
A8 Make inferences and draw conclusions using databases, spreadsheets, and other technologies
A9 Do simple trouble-shooting on common electrical and mechanical systems, identifying and eliminating possible causes of malfunctions
A10 Construct devices that perform simple, repetitive actions
A11 Investigate the functionality of various geometric shapes in the natural world and the designed world (e.g., translations from spherical to plane representations cause distortions, triangular shapes contribute to rigidity and stability in structures, round shapes minimize boundary for a given capacity)
A12 Make decisions regarding personal and public health
A13 Evaluate the social and ecological risks and benefits resulting from the use of various consumer products
A14 Analyze the contributions of advances in technology through history to his/her everyday life
A15 Identify and reduce risks and threats to a sustainable environment
A16 Extend the limits of human capabilities using technological enhancements
A17 Use and recognize various propaganda techniques
A18 Solve unique problems using the results of systematic analyses
A19 Choose everyday consumer products that utilize recent innovation and pass appropriate performance criteria
A20 Refine personal career interests through investigations of the diversity of manufacturing, research, service, and invention processes

Subunit: Applications for Science Learning (continued)
Competencies:

A21 Predict and investigate the working of toys and tools while controlling and manipulating variables (e.g., friction, gravity, forces)
A22 Write, follow, modify, and extend instructions (e.g., equations, algorithms, formulas, flow diagrams, illustrations)
A23 Create products, make inferences, and draw conclusions using databases, spreadsheets, and other technologies
A24 Predict various scenarios and propose solutions to community issues using scientific information (e.g., actuarial tables, census data, topographic maps, incidence data, climatic data)
A25 Use scientific evidence to consider options and formulate positions about the health and safety of others and him/herself
A26 Search for, use, create, and store objects and information using various strategies and methods of organization and access
A27 Research and write environmental impact statements of his/her own design
A28 Compare school-based science perspectives with those gained through cutting-edge technological applications
A29 Design management plans for natural and human-altered environments (e.g., woodlots, patios, lots, lawns, farmlands, forests)
A30 Refine personal career interests
A31 Promote public awareness of the interaction of technology with social i issues
A32 Advocate and propose courses of action for local and global scientific issues using global networks
A33 Use appropriate technologies to prepare and present the findings of investigations incorporating tables, graphs, diagrams, and text
A34 Make informed consumer choices by evaluating and prioritizing information, evidence, and strategies
A35 Develop an informed point-of-view that allows for validation or refutation of the scientific statements and claims of advocated before pursuing courses of action (e.g., contributing support, signing petitions, casting votes)
A36 Differentiate between observations and inferences in the exploration of evidence related to personal, scientific, and community issues
A37 Develop and write environmental impact and safety and hygiene management plans
A38 Use technology to collect, analyze, and communicate information (e.g., electronic networks, desktop publishing, remote sensing, graphing calculators, satellite telemetry, and others)
A39 Design, construct, and market inventions

Unit: Technology Literacy

NOTE: Over 500 Ohio business, industry, and labor representatives examined, altered, and then verified the content for this unit during the TCP Process. The original content was extracted from the Report of the Task Force on Technology Competence—Learner Goals for All Minnesotans, published by the Minnesota State Council on Vocational Technical Education. The Technology Literacy unit forms a critical link between all teachers and stresses the importance of technological impact on teaching and learning. [See "The TCP Process" for more information.]

Competencies:

T1 Demonstrate a systems view of technology based on the interdependence of social, political, economic, and ecological systems
T2 Assess the career, family, and personal development implications of technological change
T3 Demonstrate continuous learning via technology
T4 Demonstrate global appreciation for technology's potential effects on cultures, geographic areas, and the environment
T5 Apply historical perspective on technology to the development and use of new technologies
T6 Apply diverse technologies to store, access, process, create, and communicate information needed to solve problems
T7 Apply legal principles and ethical conduct to the use of technology
T8 Demonstrate competency in mathematics, science, social sciences, communication, and computer skills through the analysis, design, and evaluation of technological systems
T9 Analyze the potential of alternative technological systems to solve problems and/or to extend human capabilities
T10 Use a variety of tools, materials, and equipment in solving problems and extending human capabilities
T11 Assess risks and benefits of technological developments from an ecological, economic, social, and political perspective
T12 Value human diversity as part of a team in suggesting, designing, and testing solutions to technological problems

Unit: Employability Skills

Competency: **Develop a career plan**

Competency Builders:

Identify current interests and aptitudes
Identify common barriers to employment
Describe strategies to overcome employment barriers
Locate resources for finding employment
Research job trends
Identify career options
Identify advantages and disadvantages of career options (in addition to other than monetary)
Identify job requirements
Investigate education/training opportunities
Evaluate personal strengths and weaknesses

Competency: Prepare for employment

Competency Builders:

Identify traditional and non-traditional employment sources
Identify present and future employment opportunities (by geographic location)
Research job opportunities, including non-traditional careers
Compare salary ranges and benefit packages
Compile occupational profile
Identify rights and responsibilities of equal employment opportunity laws
Design resume and cover letter
Target resume
Secure references
Investigate generic and specific employment tests (e.g., civil service exam; drug screening)
Use follow-up techniques to enhance employment potential
Demonstrate legible written communication skills using correct grammar, spelling, punctuation, and concise wording
Describe methods for handling illegal questions on job application forms and during interviews
Write letter of application
Research prospective employer and services performed
Explain critical importance of personal appearance, hygiene, and demeanor
Interpret job description
Demonstrate appropriate interview question and answer techniques
Demonstrate methods for handling difficult interview questions
Evaluate job offers
Write letter of acceptance
Write letter of declination
Demonstrate good listening skills
Ask for the job tactfully
Participate in extracurricular activities (e.g., student government, community projects,)

Competency: Evaluate the importance of self-esteem as an employability skill

Competency Builders:

Identify factors that affect self-esteem
Compare effects of low self-esteem and high self-esteem
Identify strategies to promote positive self-esteem

Competency: Demonstrate job retention skills

Competency Builders:

Identify employer expectations regarding job performance, work habits, attitudes, personal appearance, and hygiene
Exhibit appropriate work habits and attitude
Demonstrate ability to set priorities
Identify behaviors to establish successful working relationships
Identify alternatives for dealing with harassment, bias, and discrimination based on race, color, national origin, sex, religion, handicap, or age
Identify opportunities for advancement
List reasons for termination
List consequences of being absent frequently from job
List consequences of frequently arriving late for work
Demonstrate interpersonal relations skills (i.e., verbal and written)
Demonstrate negotiation skills
Demonstrate teamwork
Follow chain-of-command
Exhibit appropriate job dedication

Competency: Demonstrate knowledge of work ethic

Competency Builders:

Define work ethic
Identify factors that influence work ethic
Differentiate law and ethics
Describe how personal values are reflected in work ethic
Describe how interactions in the workplace affect personal work ethic
Describe how life changes affect personal work ethic

Competency: Exhibit appropriate work ethic

Competency Builders:

Use time-management techniques
Avoid personal activity during work hours
Attend work as scheduled
Adhere to company and/or governmental policies, procedures, rules, and regulations
Exercise confidentiality
Demonstrate appropriate human relations skills
Adhere to rules of conduct
Accept constructive criticism
Offer constructive criticism
Take pride in work
Resolve conflict
Manage stress
Avoid sexual connotations and harassment
Adjust to changes in the workplace
Demonstrate punctuality
Assume responsibility for personal decisions and actions
Take responsibility for assignments
Follow chain-of-command

Competency: Apply decision-making techniques

Competency Builders:

Identify decision to be made
Identify ownership of decision to be made
Identify possible alternatives and their consequences
Make decisions based on facts, legality, ethics, goals, and/or culture
Apply time factor(s)
Present decision to be implemented
Evaluate decision made
Take responsibility for decision

Competency: Apply problem-solving techniques

Competency Builders:

Identify problem
Select appropriate problem solving tools/techniques
Identify root problem cause(s)
Track root problem cause(s)
Identify possible solutions and their consequences (e.g., long term, short term, crisis)
Use resources to explore possible solutions to problem
Contrast advantages and disadvantages of each solution
Identify appropriate action
Evaluate results
Identify post-preventive action

Competency: Exhibit characteristics for job advancement

Competency Builders:

Display positive attitude
Demonstrate knowledge of position
Perform quality work
Adapt to changing situations and technology
Demonstrate capability/responsibility for different positions
Identify characteristics of effective leaders
Identify opportunities for leadership in work place/community
Demonstrate initiative to affect change in workplace
Participate in continuing education/training program
Responds appropriately to criticism from employer, supervisor, or other employees
Exhibit awareness of corporate culture
Prepare for job setbacks
Exhibit continual growth based on performance evaluation
Set realistic goals

Unit: Professionalism

Competency: Project professional image

Competency Builders:

Define professionalism
Exhibit professional appearance
Exhibit professional manners
Project professional attitude
Identify individuals' vital role in organization
Exhibit proper etiquette in professionally-related situations

Competency: Achieve individual and professional goals

Competency Builders:

Set flexible, realistic, and measurable goals
Identify potential barriers to achieving goals
Identify strategies for addressing barriers to goal achievement
Breakdown long-term goals into short-term goals
Prioritize goals
Commit to goals
Adjust goals
Obtain support for goals
Reward goal achievement

Competency: Manage personal finances

Competency Builders:

Explain need for personal management records
Balance checkbook
Identify tax obligations
Analyze how credit affects financial security
Compare types and methods of investments
Compare types and methods of borrowing
Compare types and methods of insurance
Compare types of retirement options/plans
Identify discriminatory vs. non-discriminatory expenditures

Competency: Support community well-being

Competency Builders:

Identify environmental, educational, and social issues
Participate in social and/or community activities

Competency: Achieve organizational goals

Competency Builders:

Evaluate personal goals in relation to organizational goals
Monitor progress by evaluating feedback
List responsibilities in relation to organization goals
Accomplish assigned tasks
Exercise responsibility in relation to organizational goals
Set appropriate personal performance standards
Communicate goals with supervisor and peers
Demonstrate knowledge of products and services
Promote organizational image and mission

Competency: Demonstrate positive relations in the workplace

Competency Builders:

Identify personality types of self and other
Identify various management styles
Support employer expectations
Support employer decisions
Accept constructive criticism
Give constructive feedback
Adapt to changes in workplace
List factors to consider before resigning
Write letter of resignation

Competency: Manage stressful situations

Competency Builders:

Accept stress as part of daily life
Identify personal and professional factors contributing to stress
Describe physical and emotional responses to stress
Evaluate positive and negative effects of stress on productivity
Identify strategies for reducing stress
Implement strategies to manage stress
Create strategies for developing and maintaining support systems

Competency: Analyze effects of family on work and work on family

Competency Builders:

Identify how family values, goals, and priorities are reflected in work place
Identify responsibilities and rewards associated with paid and non-paid work
Identify responsibilities and rewards associated with families
Explain how family responsibilities can conflict with work
Explain how work can conflict with family responsibilities
Explain how work-related stress can affect families
Explain how family-related stress can affect work
Identify family support systems and resources
Identify work-related support systems and resources
Communicate with family regarding work

Competency: Apply lifelong learning skills

Competency Builders:

Define lifelong learning
Identify factors that cause need for lifelong learning
Analyze effects of change
Identify reasons why goals change
Describe importance of flexibility and adaptability
Evaluate need for continuing education/training

Competency: Manage professional development

Competency Builders:

Identify career opportunities
Modify career plan
Participate in continuing education/training opportunities
Document continuing education/training
Read profession-related manuals, technical journals, and periodicals
Attend meetings, workshops, seminars, conferences, and demonstrations
Participate in professional organizations
Build personal/professional mentor relationship
Build personal/professional support system
Build professional network
Strengthen communication skills
Strengthen leadership skills
Strengthen management skills

Unit: Teamwork

Competency: Demonstrate knowledge of teamwork

Competency Builders:

Define empowerment
Differentiate work groups and teams
Identify conditions essential to teamwork (e.g., brainstorming)
Explain influence of culture (e.g., corporate, community) on teamwork
Identify appropriate situations for using teams
Define team structures (e.g., cross functional, quality improvement, task force, quality circles)
Identify team building concepts
Describe characteristics and dynamics of teams
Identify characteristics of effective team leaders and members
Identify responsibilities of a valuable team member
Identify methods of involving each member of a team
Explain how individuals from various backgrounds contribute to work-related situations (e.g., technical training, cultural heritage)
Explain the purpose of facilitators
Define consensus
Define reward/recognition system

Competency: Demonstrate teamwork

Competency Builders:

Identify purpose of team and intended goal (include time frames)
Structure team around purpose
Define responsibilities of team members
Contribute to efficiency and success of team
Work toward individual and team milestones
Analyze results of team project
Facilitate a team meeting
Assist team member(s) with problem
Monitor time frame
Stress continuous improvement
Accept failure as part of learning

Competency: Use teamwork to solve problems

Competency Builders:

Identify appropriate situations for using teams
Use problem-solving process in a team setting
Identify quality management processes/techniques
Identify quality assurance processes/techniques
Prepare presentation

Competency: Conduct team meetings

Competency Builders:

Plan agenda
Schedule meeting and location
Invite appropriate personnel
Solicit outside speakers as needed
Assign someone to take minutes
Facilitate introductions
Invite questions and comments and group participation
Focus team on agenda items
Assign appropriate action, time frame and accountability to tasks
Monitor time
Close meeting on time
Publish minutes in timely manner
Set ground rules
Avoid placing individual agendas above the group's agenda

Unit: Quality Assurance

Competency: **Demonstrate knowledge of quality assurance**

Competency Builders:

Explain the historical evolution of quality assurance (e.g., Deming, ISO 9000)
Explain changes brought about by quality leaders in the world
Explain the ISO 9000 process
Define quality terms
Define quality functions
Identify features of quality planning
Describe control devices used in functional areas (e.g., SPC, equipment)
Explain the relationship among organizational structures, policies, procedures, and quality assurance
Explain importance of internal and external customers
Identify internal and external customers
Describe successful efforts by industry to improve quality and/or reduce costs
Differentiate prevention and detection
Differentiate variable and attribute data
Identify types of coontrol charts
Explain how statistical techniques are tools used to control quality (e.g., SPC, DOE, CR)

Competency: **Demonstrate knowledge of quality cost implications**

Competency Builders:

Identify cost/quality objectives
Classify costs (i.e., direct and indirect, fixed and variable, methods and standards)
Classify quality costs (i.e., prevention, evaluation, pre-delivery failure, post-delivery failure)
Define produce liability
Interpret quality cost reports
Explain consumerism and liability prevention
Define safety terms of product
Identify safety responsibility within organization
Define contracts and torts
Differentiate express and implied warranty
Differentiate warranty and product liability
Explain how warranties are part of contract law
List questions that would need answering in liability claim

Competency: **Demonstrate knowledge of engineering a quality product**

Competency Builders:

Associate customer satisfaction with product characteristics (e.g., usefulness, price, operation, life, reliability, safety, cost of operation)
Define manufacturability
Identify steps in product design (e.g., brainstorming, thumbnail sketches, rendering)
Define reliability factors (e.g., cost, human, producibility)
Identify ways reliability is achieved (e.g., maintainability, good design, design simplification, design redundancy)
Explain the relationship of maintainability to reliability
Define failure
Explain the role of testing and reliability
Define value engineering
Define quality objectives
Identify cost components as they relate to quality objectives
Classify quality costs (i.e. preventive, evaluation, pre-delivery failures, post delivery failures)
Describe predictive maintenance

Competency: **Explain importance of interdepartmental relationships to quality assurance**

Competency Builders:

Explain need for everyone's commitment in assuring quality
Explain phrase "Everyone is a customer/supplier"
Define quality improvement team models
Explain the importance of top management's support of quality
Explain project selection
Explain project implementation
Explain project evaluation
Explain continuing improvement
Describe future trend of experiment design
Describe future trend of predictive maintenance

Competency: **Manipulate quality cost data**

Competency Builders:

Develop quality cost data
Translate cost reports
Graph quality cost data (e.g., pareto)

Competency: **Manipulate cost control data**

Competency Builders:

Develop cost control data
Analyze cost control reports
Provide cost control data
Provide advice on "Make or Buy" decisions (including economical lot size decisions)

Competency: Demonstrate knowledge of basic statistics

Competency Builders:

Describe data collection methods
Collect data
Organize data by flow chart
Interpret data by cause and effect diagrams
Define nominal, ordinal, interval, and ratio data
Define mean, median, and mode
Explain significance of standard deviation
Explain normal distribution

Competency: Demonstrate knowledge of scattergrams

Competency Builders:

Construct scattergram
Interpret for positive, negative, or no correlation between X and Y variables
Test for significance between one and five percent
Explain regression analysis

Competency: Demonstrate knowledge of probability theory

Competency Builders:

Define classical probability
Define empirical probability
Calculate probability for outcomes

Competency: **Demonstrate knowledge of precontrol**

Competency Builders:

Explain uses of precontrol
Calculate precontrol limits
Explain significance of the limits
Plot values on a precontrol chart
Explain "out-of-control" situation
Make decisions on green, yellow and red conditions

Competency: **Demonstrate knowledge of process capability**

Competency Builders:

Use X, R, USL, and LSL to determine process capability (upper and lower specification limits)
Calculate estimated process standard deviation
Plot right hand and left hand tail of process variation
Compute Z value for percent of probable defect for process
Calculate C_{PK} values that describe process capability
Describe skewed distributions
List probable causes of skewed distribution

Competency: **Use quality control charts**

Competency Builders:

Identify operational definitions for attribute criteria
Interpret histogram
Interpret scattergrams
Interpret NP chart
Interpret P chart
Interpret flowchart
Interpret cause-and-effect diagram
Construct P (percentage defective) chart for attributes
Plot control limits of P chart and data points
Check chart for out-of-control conditions
Construct an NP (number defective) chart with control limits and data
Construct C (count of defects) and U (number of defects per unit) charts
Check data on C and U charts
Construct flowchart
Construct cause-and-effect chart

Competency: **Interpret $\overline{X}$ and R charts**

Competency Builders:

Plot percentages for normal distribution
Test distribution for normality
Explain difference between common cause and special cause
Define an "in-control" process
Explain significance of an out-of-control point on $\overline{X}$ or R chart
Identify patterns and trends on control chart
Identify run up and run down
Test for middle third on control chart
Explain significance of middle third on control chart
Explain Rule of Sevens

Competency: Construct $\overline{X}$ and R charts

Competency Builders:

Arrange data into statistical sub-groups
Explain importance of random sampling
Compute $\overline{X}$ (i.e., average of values) and R (i.e., range of values in subgroup) within sample
Plot in $\overline{X}$ and R on chart
Construct control chart with $\overline{\overline{X}}$ (grand average) and R (average range) calculated
Calculate upper and lower control limits for $\overline{X}$-chart
Calculate upper and lower control limits for R-chart

Competency: Conduct process improvement studies

Competency Builders:

Analyze production methods and processes applying statistical process improvement techniques (e.g., SPC, C_{PK})
Identify appropriate statistical techniques for study (e.g., T-tests, F-test, capability, DOEX)
Identify major steps in conducting a study
Define "report" for a study (e.g., goal, objective, study conduct, results, conclusions, discussions)
Integrate results into the total system

Competency: **Demonstrate knowledge of JIT**

Competency Builders:

Define just-in-time concept (JIT)
Describe various production methodologies (e.g., standard cycle times, routings, standard quantities, multiple-machine tending)
Describe types of inventory control (e.g., Kanban)
Describe importance of flexibility
Differentiate product layout, process layout, fixed position layout, and cellular layout
Differentiate straight-line, U-shaped, S-shaped, convoluted and comb patterns
Describe advantages/disadvantages of layout and patterns
Explain importance of product protection, identification and storage
List methods of identifying products (e.g., labels, bar codes, radio frequency systems and magnetic strip systems)
Describe manual methods of storage and retrieval
Describe automated storage and retrieval systems (ASRS)
Describe automated guided vehicle moving systems (AGVS)

Competency: **Apply JIT**

Comptency Builders:

Maintain system for physical handling and movement of material in-process and in-storage
Monitor system of physical handling and movement of material in-process and in-storage
Maintain system for physical handling and movement of finished products
Monitor system of physical handling and movement of finished products
Write requests for deviation from specifications
Implement quality control and inspection standards and procedures
Write engineering change notices and rejection reports
Monitor reports of discrepancy or rejects during production process
Conduct quality tests under different environmental conditions

Competency: Demonstrate knowledge of inspection

Competency Builders:

Explain purpose of inspection
Describe scope of inspection
Explain purpose of incoming, ongoing, and final inspections
Explain early detection inspection
Explain how statistical process control (SPC) aids inspection
Define types of nonconformance
Define degrees of nonconformance
Define corrective action
Describe when to 100% inspect
Describe when to sample inspect
Describe methods of testing for material properties (e.g., harness, strength, chemical makeup, flaws, errors in tooling or setup)
Define rework, salvage, and scrap
Describe ethical decisions an inspector may make
Identify purposes of computer-automated inspection
Explain advantages and limitations of automated inspection
Explain disposition of non-conforming material
Explain basic foolproofing concept to build inspection into process (i.e., poka-yoke)
Use checksheets to organize and record inspection results

Competency: Inspect machinery, materials, and products

Competency Builders:

Identify critical material characteristics from specification(s) or drawing(s)
Perform capability studies for machinery and materials acceptance
Identify appropriate acceptance sampling plan
Conduct incoming materials inspection using sampling plan criteria
Identify critical in-process characteristics from specification(s) or drawing(s)
Demonstrate basic metrology skills
Conduct in-process inspection
Identify appropriate inspection reports and follow-up
Gauge R and R (reproducibility and repeatability)
Apply geometric tolerancing
Explain C = O (zero) acceptance plan
Interpret instructions in a control plan

Competency: **Demonstrate knowledge of nondestructive testing**

Competency Builders:

Describe purpose of nondestructive testing
Identify anomalies
Define defects and discontinuities
Identify factors contributing to defects and discontinuities
Describe ultrasonic testing
Describe advantages and limitations of ultrasonic testing
Describe industrial radiography
Compare use of wet and dry particles in magnetic particle inspection
Explain advantages and limitations of penetrant inspection
Describe microwave testing
Describe holographic inspection
Explain choice of most suitable nondestructive test method
Describe eddy-current testing

Unit: Technical Recording and Reporting

Competency: Demonstrate proficiency in technical recording

Competency Builders:

Describe various documentation procedures
Interpret specifications or drawings
Observe process
Ask open-ended questions
Record process (e.g., flowchart, step-by-step)
Identify parameters
Record accurate, truthful data
Maintain test logs
Compile cumulative reference notebook/record
Measure appropriate parameters
Draft preventive maintenance and calibration procedures

Competency: Demonstrate proficiency in technical reporting

Competency Builders:

Use data books and cross reference/technical manuals
Compose technical memoranda
Identify type of report or format needed
Use appropriate format
Compile relevant data
Design charts and graphs
Analyze data
Draw conclusions
Explain analytical methods used
Outline reports
Write reports
Present reports

Unit: Computer Literacy

Competency: Describe personal computer operations

Competency Builders:

Explain how data is stored in main computer memory
Explain how computer system executes program instruction
Explain computer storage capacity
Explain how data is represented
Describe data storage techniques
Identify types of memory

Competency: Explain information processing cycle

Competency Builders:

Define operating systems (e.g., DOS, OS/2, UNIX, MAC)
Describe computer languages and their use
Describe computer languages and their use
Describe computer languages and their use
Describe difference between data files and program files
Explain PC layout
Explain PC network layout
Explain mini/mainframe network layout
Differentiate hardware and software
Differentiate open from proprietary architecture

Competency: Operate computer hardware

Competency Builders:

Practice proper media handling techniques (e.g., magnetic fields, dust, liquids)
Identify hardware and its use
Use hardware (e.g., mouse, diskettes, drive, modems, touch screen, printers, digitizers, scanners, cables, protection devices)
Keyboard efficiently
Demonstrate basic care of hardware
Explain need for and application of security levels/procedures
Perform basic hardware troubleshooting
Explain hardware addressing techniques

Competency: Use software

Competency Builders:

Define software types and functions
Describe basic disk operations and care
Perform functions necessary to operate software
List advantages and disadvantages of integrated and dedicated software
Operate system software
Operate diagnostic software
Demonstrate basic proficiency in spreadsheet use
Demonstrate basic proficiency in word processing
Demonstrate basic proficiency in database use
Demonstrate basic proficiency in network use
Demonstrate basic proficiency of utility (e.g., WINDOWS, GUI)
Demonstrate basic proficiency in report writing
Demonstrate system commands
Differentiate ethical use/misuse of software
Describe bulletin boards/electronic mail
Apply security levels/procedures while handling sensitive data
Explain data compression techniques
Explain use and deletion of passwords

Unit: Workplace Safety

Competency: Apply general safety precautions

Competency Builders:

Identify local, state, and federal rules and regulations
Identify personal protective wear and equipment
Identify visual controls (e.g., monitors, read outs)
Identify auditory controls
Identify common sense housekeeping
Interpret hazardous materials notices on containers
Use personal protective wear and equipment
Apply workplace safety rules and procedures
Apply personal safety rules and procedures
Apply workplace organization (e.g., housekeeping)
Apply applicable electrical, mechanical, steam, hydraulic and (e.g., pneumatic safety rules and procedures)
Apply fire safety rules and procedures
Apply hazardous wastes rules and procedures
Apply first aid
Locate (MSDS)
Perform lockout and tagout
Recycle scrap metal, chips, shavings, coolants, solvents, trash, and waste materials
Apply common sense housekeeping
Use preventive maintenance checklists

Competency: **Demonstrate knowledge of safety and workplace hazards**

Competency Builders:

Describe corrective procedures for unsafe conditions
Identify types and potential level of workplace hazards (e.g., physical hazards, fire, chemicals, noise, ionizing radiation, ultraviolet, temperature extremes, ergonomics, biological hazards)
Identify safety materials/equipment (e.g., absorbant socks, oil dry)
Interpret Material Safety Data Sheets (MSDS)
Explain purpose(s) of OSHA and NIOSH
Explain purpose(s) of NEC and NFPA
Identify purpose of emergency evacuation routes, master switch and lockout locations, and safety color coding systems
Identify roles of industrial hygienists, safety professionals, occupational physicians, and occupational nurses
Describe methods of evaluating potential hazards (e.g., visual analysis)
Describe methods of correcting potential hazards
Describe various types of toxicity (e.g., chronic, immediate)
Identify need for reporting accidents
Explain precautions required when using toxic or flammable materials
Define confined space and related requirements
Explain how international directives relate to safety

Competency: **Explain purpose of industrial pollution control systems**

Competency Builders:

Describe types of air, water, solid waste, and noise pollution
Explain purpose of air pollution control systems
Explain purpose of water pollution control systems
Explain purpose of solid waste pollution control systems
Explain purpose of noise pollution control systems
Explain basic philosophy of "right to know" legislation
Explain purpose(s) of EPA
Identify "costs" of industrial pollution control (i.e., dollars vs. impact to environment)
Describe ethics of environmental issues

Competency: Demonstrate knowledge of ergonomics

Competency Builders:

Define ergonomics
Define risk factor
Define maximum permissible limit (MPL) and action limit (AL) for lifting
Define cumulative trauma disorder (CTD)
Identify susceptibility factors for CTD
Minimize extreme joint movement
Minimize use of excessive muscle force
Minimize repetitive tasks
Minimize mechanical stresses (e.g., sharp edges, heat, cold, hard surfaces, weights, vibration)
Minimize awkward body positions
Explain use of rest pauses
Explain need for mats and footrest for standing jobs
Explain need for appropriate working heights of chairs, stools, workbenches, equipment
Explain need for adequate lighting
Explain use of anthropometric (i.e., centering one's view of everything around man) design

Unit: Supervision

Competency: Perform supervisory functions

Competency Builders:

Define supervision
Conduct task analysis
Create organizational and/or departmental charts
Apply company policies and procedures
Maintain workplace procedures manuals
Prepare budgets
Monitor budgets
Prepare managerial reports
Analyze daily production reports
Maintain appropriate work environment
Conduct tours
Facilitate assignments
Assign work
Delegate job tasks
Monitor progress
Prepare productivity reports
Provide training for new policies
Troubleshoot workplace problems
Coordinate workplace activities
Appraise performance
Document personnel issues
Coordinate administrative duties

Competency: Coordinate training

Competency Builders:

Assess training needs
Secure training resources, materials and equipment
Train employees
Evaluate progress of trainee
Provide feedback
Solicit feedback
Receive feedback
Assess feedback

Unit: Troubleshooting and Repair

Competency: Demonstrate troubleshooting skills

Competency Builders:

Explain role of preventive maintenance
Differentiate normal and abnormal operations
Explain troubleshooting procedures
Explain logical actions taken to troubleshoot
Use proper troubleshooting aids
Demonstrate knowledge of safety rules for troubleshooting and repair procedures
Maintain troubleshooting and repair records
Interpret prints (e.g., PID, loopsheets)
Use manufacturer's manuals, schematics, and troubleshooting charts
Isolate faults, shorts, and open circuits

Competency: Apply troubleshooting techniques to DC circuits

Competency Builders:

Identify noise problems
Isolate faults in series, parallel and series parallel
Isolate faults in bridge circuits
Isolate faults in DC power supplies
Perform polarity check
Isolate faults to DC drive system
Isolate faults in voltage divider circuits
Repair faults

Competency: **Apply troubleshooting techniques to AC circuits**

Competency Builders:

Isolate faults in capacitive circuits
Isolate faults in inductive circuits
Isolate faults in AC circuits utilizing transformers (e.g., step up and step down)
Isolate faults in differentiator and integrator circuits
Isolate faults in RC, RL, and RLC circuits
Isolate faults in frequency selective filter circuits
Isolate faults to AC frequency drive systems
Repair faults

Competency: **Apply troubleshooting techniques in discrete solid-state devices**

Competency Builders:

Isolate faults in diode circuits
Isolate faults in thyristor circuitry (e.g., SCR, TRIAC, DIAC)
Isolate faults in transistor circuits
Isolate faults in operational amplifier circuits
Isolate faults in single-stage amplifiers
Isolate faults in open circuits
Repair faults

Competency: **Apply troubleshooting techniques to analog circuits**

Competency Builders:

Isolate faults in single and multistage amplifiers
Isolate faults in audio power amplifiers
Isolate faults in regulated and switching power supply circuits
Isolate faults in active filter circuits
Isolate faults in oscillator circuits
Isolate faults in operational amplifier circuits
Isolate faults in power supplies (loaded and unloaded) and filters
Repair faults

Competency: **Apply troubleshooting techniques to digital circuits**

Competency Builders:

Identify noise problems
Isolate faults in multiplexer and demultiplexer circuits
Isolate faults in digital display circuits
Isolate faults in logic gates
Isolate faults in flip-flops
Isolate faults in registers and counters
Isolate faults in clock and timing circuits
Isolate faults in arithmetic-log circuits
Isolate faults in encoders and decoders
Isolate faults in digital-display devices
Repair faults

Competency: **Apply troubleshooting techniques to a microcomputer system**

Competency Builders:

Isolate faults to systems boards
Isolate faults to memory circuits
Isolate faults to data storage devices
Isolate faults in power supplies
Troubleshoot I/O ports
Isolate faults in I/O interface circuitry
Use diagnostic software
Repair faults

Competency: **Apply troubleshooting techniques to manufacturing systems**

Competency Builders:

Identify individual process blocks of assembly line or process
Identify process block interfaces
Demonstrate steps required for efficient systems troubleshooting
Isolate system faults to process block
Isolate block faults using schematics
Isolate block faults using programmable controller indicators
Isolate block faults using volt meter
Repair block faults by replacing fault component or wiring

Unit: Industrial Electricity

Competency: Explain basic industrial electricity theory

Competency Builders:

Describe atomic structure and its relationship to electricity
Describe the relationship between electrical and magnetic properties
Describe the electrical and magnetic properties of a magnet
Describe the photoelectric effect
Describe the thermocouple effect
Describe the electrical effect of friction
Identify sources of electricity
Identify potential sources of electricity
Describe differences between AC/DC
Describe effects varying degrees of electricity have on the human body

Competency: Use the National Electrical Code (NEC)

Competency Builders:

Use NEC to identify correct materials
Use NEC to identify correct methods
Use NEC to identify correct applications
Use NEC to identify correct safety procedures

Competency: Explain operation of electrical distribution systems

Competency Builders:

Follow NFPA, local, state, and national codes
Describe functions of permits and licensing requirements
Explain generation of electricity
Explain transmission of electricity
Explain end user distribution

Competency: Maintain basic electrical systems

Competency Builders:

Replace electrical cords
Replace batteries
Replace fuse(s)
Replace switches and other sensors
Replace plugs and sockets
Replace control panel components (e.g., relays, motor starters)
Replace AC motors (e.g., 3 phase, single phase)
Replace DC motors

Competency: Interpret electrical/electronic drawings

Competency Builders:

Interpret basic electric/electronic standards and symbols (e.g., NEC, IEC)
Interpret schematic drawings
Interpret cable drawings
Interpret component drawings
Interpret logic diagrams
Interpret control panel drawings
Interpret connection drawings
Interpret interconnection drawings
Interpret printed circuit board drawings
Interpret harness drawings
Interpret package drawings
Interpret mechanical/electronic production blueprints and assembly drawings

Competency: **Demonstrate proficiency in direct current (DC) circuits**

Competency Builders:

Describe voltage, current, resistance, power, and energy
Solve algebraic problems to include exponential (prerequisite to DC)
Measure properties of a circuit using volt-ohm meter (VOM) and digital volt-ohm meter (DVM) meters and oscilloscopes
Apply Ohm's Law
Construct parallel circuits
Construct series circuits
Construct series parallel and bridge circuits
Define voltage divider circuits (loaded and unloaded)
Construct DC circuits that demonstrate the maximum power transfer theory
Solve problems in electrical units utilizing metric units
Describe the principles and operation of electrochemical supplies
Apply Kirchoff's law
Interpret color codes and symbols to identify electrical components and values
Measure properties of a circuit using analog and digital meters and oscilloscopes
Measure conductance and resistance of conductors and insulators
Describe magnetic properties of circuits and devices
Describe the physical and electrical characteristics of capacitors and inductors
Describe RC and RL time constants
Set up power supplies for DC circuits
Operate power supplies for DC circuits
Analyze frequency spectrums
Apply Thevenin's and Norton's theorems

Competency: **Demonstrate proficiency in alternating current (AC) circuits**

Competency Builders:

Solve basic trigonometric problems as applicable to electricity (prerequisite to AC)
Analyze AC signals utilizing VOM, DVM, oscilloscope, frequency counter and function generator
Analyze power in AC circuits
Measure power in AC circuits
Operate capacitor and inductor analyzers for AC circuits
Analyze properties of an AC signal
Describe the principles and operation of the characteristics of sinusoidal and non-sinusoidal wave forms
Identify AC sources
Describe the principles and operation of the characteristics of capacitive circuits
Demonstrate the operation of capacitive circuits
Describe the principles and operation of the characteristics of inductive circuits
Demonstrate the operation of inductive circuits
Describe the principles and operation of the principles of transformers
Demonstrate the operation of AC circuits utilizing transformers
Operate differentiators and integrators to determine RC and RL time constants
Describe the principles and operation of the characteristics of RLC circuits (series, parallel, and complex)
Demonstrate the operation of RLC circuits (series, parallel, and complex)
Describe the principles and operation of the characteristics of series and parallel resonant circuits
Operate series and parallel resonant circuits
Describe the principles and operation of the characteristics of frequency selective filter circuits
Demonstrate the operation of frequency selective filter circuits
Operate polyphase circuits
Describe basic motor theory and operation
Describe basic generator theory and operation
Operate power supplies for AC circuits
Describe the principles and operation of various power conditioning (e.g., isolation transformers, surge suppressors, uninterruptable power systems)
Describe the principles and operation of various safety grounding systems (e.g., lightning arresters, ground fault interrupters, etc.)
Apply maximum power transfer theorems
Apply Thevenin's and Norton's theorems to analyze AC networks

Unit: Drafting Technology

Competency: Apply basic drafting skills

Competency Builders:

Use drafting equipment, measuring scales, drawing media, drafting instruments and consumable materials, blueprint machine
Identify line styles, weights (alphabet of lines)
Select proper drawing scale, introduction to different types
Prepare title blocks and other drafting formats
Apply freehand and other lettering techniques
Prepare multi-view drawings
Prepare multi-view sketches
Prepare orthographic views
Prepare change control block
Describe change control block/revision block
Measure angles
Draw horizontal, vertical, angular, parallel, and perpendicular lines
Transfer an angle
Construct tangent lines (to arcs) and tangent arcs (to arcs)
Bisect angles and arcs
Bisect lines
Divide lines
Construct three-point circle
Construct regular hexagon, pentagon, and octagon
Reproduce a drawing
Prepare single-view drawings
Prepare dimension drawings
Interpret notes and dimensions to determine part
Draw arcs, circles, and conics
Transfer measurements

Competency: Apply intermediate drafting skills

Competency Builders:

Describe types of blueprints and their applications
Apply isometric, oblique and perspective sketching techniques
Prepare isometric, oblique and perspective sketches
Prepare sectional views
Prepare auxiliary views
Identify ANSI symbols
Prepare views of drilled and tapped holes, counterbores, countersinks
Apply systems drafting techniques
Identify a bill of materials
Dimension drawings using ANSIy14.5 standards
Describe purpose of auxiliary and sectional views

Competency: Apply advanced drafting skills

Competency Builders:

Interpret reports and specifications
Prepare pictorial drawings
Prepare schematics
Draw conics
Interpret basic pneumatic/hydraulic standard and symbols
Interpret various drawings (e.g., welding, casting, stamping, forging, civil, maps, pattern shop)

Competency: Interpret basic prints

Competency Builders:

Visualize object from drawing
Interpret orthographic projections
Interpret isometric views
Interpret sectional views
Interpret detail and assembly drawings
Interpret dimensions
Interpret tolerances

Competency: Interpret intermediate prints

Competency Builders:

Interpret screw thread specifications
Identify structural steel shapes
Interpret special symbols
Interpret electrical, pneumatic/hydraulic drawings
Interpret schematics

Competency: Interpret advanced prints

Competency Builders:

Interpret GD&T characteristic symbols
Interpret GD&T supplementary symbols

Competency: Demonstrate knowledge of basic geometric dimensioning and tolerancing

Competency Builders:

Identify geometric characteristics and symbols (i.e., flatness, straightness, roundness, cylindricity, profile of line, profile of surface, perpendicularly, angularity, parallelism, circular, runout, total indicated runout, position, concentricity, and symmetry)
Define maximum material condition
Define least material condition
Define regardless of feature size condition
Describe feature control blocks
Describe datum surfaces and targets
Define flatness (pitch)
Define straightness (yaw)
Define roundness
Define cylindrically
Define profile of line
Define profile of surface
Define perpendicularity
Define angularity
Define parallelism
Define circular runout
Define total runout
Define true position concept to determine tolerance for location of holes in mating parts

Competency: Convert dimensions and tolerances

Competency Builders:

Convert dimensions and tolerances from English units to metric units
Convert dimensions and tolerances from metric units to English units

Competency: Apply revision control process

Competency Builders:

Apply drawing balloons
Apply documentation (including project filing, back-up material, tracking process)
Apply change control block
Apply revision levels

Competency: Demonstrate dimensioning techniques

Competency Builders:

Construct arrowheads using various styles/disciplines
Apply symbols for surface and texture control
Add labels/notes to drawing
Interpret decimal tolerance dimensions
Dimension arcs
Dimension angles
Dimension curves
Dimension rounded-end shapes
Dimension spherical objects
Dimension cylindrical objects
Dimension cones, pyramids, and prisms
Dimension features on circular center line
Dimension theoretical point of intersection
Dimension object using rectangular coordinate system
Dimension object using polar coordinate system
Dimension object using tabular coordinate system
Dimension object using ordinate dimensioning system

Competency: Apply geometric dimensioning and tolerancing

Competency Builders:

Interpret decimal tolerance dimensions
Calculate clearance fit tolerances of mating parts
Dimension clearance fit tolerances of mating parts
Calculate interference fit tolerances of mating parts
Dimension interference fit tolerances of mating parts
Calculate tolerances to mating parts using standard fit tables
Assign tolerances to mating parts using standard fit tables
Apply positional and form tolerancing symbols
Apply symbols for true position
Apply symbols for maximum material control and regardless of feature size
Calculate effects of dimensional stack-up
Calculate transitional fit tolerances
Dimension transitional fit tolerances

Competency: Perform basic physical layouts

Competency Builders:

Use inside diameter (ID), outside diameter (OD), and hermaphrodite calipers
Layout with combination square
Layout with scriber, divider and trammel
Use surface plate
Use surface gage
Use layout fluid
Use V-blocks
Use clamps
Use angle plate
Use parallels
Use punches
Use transfer method tools
Use layout hammer
Use machinist's square
Use universal bevel protractor
Use machinist's scale

Competency: Prepare mechanical drawings

Competency Builders:

Interpret basic mechanical standards and symbols
Prepare assembly drawings
Prepare welding drawings
Prepare bearing drawings
Prepare casting drawings
Prepare forging drawings
Prepare tool drawings
Prepare molding diagrams
Prepare drawings with special processed holes
Prepare stamping drawings
Prepare numerical control drawings/instructions
Prepare installation drawings
Prepare purchase part drawings
Prepare approval drawings

Competency: Prepare advanced mechanical drawings

Competency Builders:

Resolve problems by descriptive geometry and revolutions
Use precision dimensioning to include geometric characters
Use precision measuring instruments (e.g., calipers)
Prepare fastener drawings
Prepare cam drawings
Prepare gear drawings
Prepare spring drawings
Prepare pulley and chain drive drawings

Unit: CADD Fundamentals

Competency: Demonstrate basic use of computer operating system

Competency Builders:

Create ASCII text files with a text editor
Explain rules for naming files and directories
Manage files
Create directories
Remove directories
Change directories
Copy files
Rename files
Erase files
Format diskettes
Label diskettes
Explain the syntax of operating system commands
Use wildcards in operating system commands

Competency: Operate a CADD system

Competency Builders:

Execute CADD system
Use keyboard input
Use screen and tablet menus
Use other input devices (e.g., scanner, digitizer)
Create scaled plots
Operate a pen plotter
Operate a printer-plotter (i.e., laser plotter)
Access on-line help for commands
Use file conversion
Use data transfer

Competency: Select entities for action

Competency Builders:

Add or remove entities separately
Add or remove entities using a window
Add or remove entities with a crossing-box
Select entities using a fence
Select entities by other methods (e.g., last, previous, type, all, etc.)

Competency: Create 2-D orthographic drawings

Competency Builders:

Create primitive drawing entities
Draw utilizing absolute Cartesian coordinates
Draw utilizing relative Cartesian coordinates
Draw utilizing polar coordinates
Draw using construction aides (e.g., snaps, grid, snap, etc.)
Change drawing attributes
Edit drawing entity properties (e.g., color, layer, thickness, linetype)
Construct drawing entities (e.g., offset, timer, extend, break, mirror, etc.)
Edit drawing entities (e.g., offset, trim, extend, break, mirror, etc.)
Set system variables (e.g., units, scale)
Use system variables
Create layers
Name layers
Manipulate layers
Save files
Create back-ups
Create hatches, patterns, symbols
Recall drawing templates/blocks

Competency: Annotate orthographic drawings

Competency Builders:

Create text styles
Edit text styles
Select text styles
Apply notes

Competency: Dimension orthographic drawings

Competency Builders:

Create dimensions
Edit text
Control dimension variables/models

Competency: Control display

Competency Builders:

Apply view control while drawing (e.g., zoom and pan)
Control view resolution (e.g., viewers)
Save views
Display views

Competency: Extract entity and drawing information

Competency Builders:

Measure distances
Measure areas
Identify locations
List entity characteristics (e.g., length, size, location, properties, etc.)

Unit: Intermediate CADD

Competency: Manage symbols and attributes

Competency Builders:

Create blocks and W-blocks/templates
Create nested blocks/templates
Insert blocks and drawings/templates
Redefine blocks/templates
Edit blocks/templates
Apply attributes

Competency: Create 2-D isometric drawings

Competency Builders:

Manipulate snap and grid settings
Toggle planes (e.g., left, right, top)
Create text styles for each plane
Create dimension styles
Use dimension styles
Create isometric ellipses

Competency: Use external routines

Competency Builders:

Load AutoLISP programs
Execute AutoLISP programs
Load ADS programs
Execute ADS programs

Competency: Create custom menus

Competency Builders:

Demonstrate search routines when using a text editor
Write screen menus and macros
Write tablet menus and macros
Write cascading pop-down menus and macros
Write icon menus and macros
Write button menus and macros
Write other customizable CADD files (e.g., ACADD.PCP)
Edit other customizable CADD files (e.g., ACADD.PCP)

Competency: Create script files

Competency Builders:

Write a slide show script
Write a script for setting initial variable settings
Write a script for creating a title-block

Competency: Create custom linetypes

Competency Builders:

Formulate a linetype composed of long dashes
Formulate a linetype composed of lines, dashes and dots

Competency: Create 3-D wireframe models

Competency Builders:

Differentiate among extrusions, wireframes, surface models, and solid models
Create user coordinate systems
Manipulate user coordinate systems
Use cylindrical coordinates
Use spherical coordinates
Use .XYZ filters
Project geometry from one plane to another

Competency: **Create 3-D surface models**

Competency Builders:

Define B-rep surfaces
Differentiate B-rep surfaces and non-uniform rational B-splines (NURB's)
Create tabulated surfaces
Create ruled surfaces
Create revolved surfaces
Create edge surfaces (e.g., coon's patch)
Apply surface meshes to 3-D wireframes
Modify visibility of the edges of faces
Dimension a 3-D model for both isometric and orthographic drawings
Control dimension scale with regard to plotting scale

Competency: **Apply advanced control display techniques**

Competency Builders:

Define camera viewpoints and angle of rotation
Control display angle (e.g., d-view, v-point)

Unit: Equipment Installation

Competency: Explain installation procedures

Competency Builders:

Explain relocation procedures for new equipment in an existing facility
Explain the use of anchors and isolators
Explain procedures for moving and installing new equipment
Explain leveling and aligning procedures
Explain test run guidelines
Explain safety precautions for equipment installation procedures
Explain grounding procedures
Explain installation of utilities (e.g., electricity, air, water, drains)

Competency: Prepare for equipment installation

Competency Builders:

Identify equipment requirements (including safety)
Identify maintenance services needed
Identify method of moving and equipment needed
Identify measuring devices
Calculate weights
Follow manufacturer's specifications and mannuals
Identify applicable electrical, mechanical, hydraulic, and/or pneumatic principles
Read drawings/schematics
Revise drawings if applicable
Interpret prints

Competency: Install Equipment

Competency Builders:

Prepare site
Use measuring devices
Calculate weight
Follow manufacturer's specifications
Use appropriate moving equipment
Align equipment to layout specifications
Apply electrical, mechanical, hydraulic, and/or pneumatic principles

Competency: Explain rigging functions

Competency Builders:

Estimate the weight of a load
Find the center of gravity
Identify the rigging and slings used in maintenance work
Explain safety inspection procedures for rigging, ropes, and slings
Perform safety inspection procedures for rigging, ropes, and slings
Identify rope fiber types
Tie rigging knots, bends, and hitches
Identify types of wire rope
Cut wire rope assemblies and termination's
Identify cranes and hoists
Identify and explain scaffolding types
Identify safety equipment (e.g., life belts, nets, etc.)

Competency: Perform rigging functions

Competency Builders:

Perform safety inspection procedures for rigging, ropes, and slings
Tie rigging knots, bends, and hitches
Cut wire rope
Seize wire rope
Install wire rope eyes, sockets, and hooks
Splice wire rope
Erect a scaffold
Rig life belts and nets

Unit: Equipment Maintenance

Competency: Perform housekeeping

Competency Builders:

Dispose of scrap metal chips, shavings, trash and waste
Clean work area
Store hand tools, cutters, fixtures, jigs and attachments
Store grinding wheels
Follow tool crib procedures
Inspect machine guards
Replace or adjust machine guards
Report problems to supervisor

Competency: Perform recordkeeping

Competency Builders:

Explain reasons for keeping maintenance records
Explain reasons for keeping cost records
Complete work order
Complete internal requisition
Complete external requisition
Complete time cards
Complete job status reports
Complete equipment failure reports
Record preventive maintenance activities
Record repair activities
Read job orders and process sheets
Locate tooling and set up information
File reports
Prepare new/replacement equipment recommendations

Competency: Inspect machine systems

Competency Builders:

Explain planned maintenance
Explain predictive maintenance measures
Explain preventive maintenance measures (e.g., lubrication)
Log machine histories
Explain machine system(s) calibration
Inspect linkages and lever mechanisms
Inspect drive couplings
Inspect clutches
Inspect roller ball bearings
Inspect safety systems
Analyze system failure
Make minor adjustments/repairs
Coordinate maintenance services

Competency: Perform machine maintenance

Competency Builders:

Use operator's and manufacturer's manuals
Operate individual machines
Diagnose malfunctions
Apply lockout/tagout procedure
Disassemble defective section
Clean equipment
Lubricate equipment
Check equipment for wear and alignment
Repair or replace defective parts
Test machine for performance
Make minor adjustments to equipment

Competency: Maintain hand tools

Competency Builders:

Demonstrate use and care of measuring devices (e.g., rules, tapes, calipers, micrometers, multimeter, thermometer, and coordinate measuring system)
Demonstrate use and care of equipment used to bend and assemble rigid conduit and tubing
Demonstrate use and care of common hand tools
Demonstrate use and care of wood working tools (e.g., saws, planes, drills, hammers)
Demonstrate use and care of sheet metal tools (e.g., sheet metal gauges, hand seamers, soldering irons)
Demonstrate use and care of ropes, slings, pullers, and block and tackle
Demonstrate proper metal working bench skills (including use of vices, hacksaws, files, tapes, dies, and reamers)
Demonstrate use and care of pipe clearing equipment

Competency: Maintain portable power tools

Competency Builders:

Demonstrate use and care of light-duty and heavy-duty drills
Demonstrate use and care of electric hammers
Demonstrate use and care of pneumatic drills and hammers
Demonstrate use and care of power screwdrivers and impact wrenches
Demonstrate use and care of linear motion saws
Demonstrate use and care of circular saws
Demonstrate use and care of routers and planes
Demonstrate use and care of belt, pad and disc sanders
Demonstrate use and care of grinders and shears
Demonstrate use and care of explosive actuated tools
Demonstrate use and care of electric lifts

Competency: Maintain stationary equipment

Competency Builders:

Demonstrate use and care of mechanical presses
Demonstrate use and care of hydraulic presses
Demonstrate use and care of drill presses
Demonstrate use and care of bench grinders
Demonstrate use and care of power saws (e.g., hack, cut-off, chop, band, jig, and table)
Demonstrate use and care of band saws
Demonstrate use and care of pipe threaders
Demonstrate use and care of metal brakes
Demonstrate use and care of power shears

Unit: Mechanical Power Transmission

Competency: Demonstrate knowledge of basic mechanics

Competency Builders:

Explain working forces of torque, tension, and compression
Explain the laws of motion
Explain how to calculate work in several ways
Explain the function of simple machines including levers, inclined plane, wedge wheel and axle, pulley and screw, gears
Explain the types of power and the method of producing power
Explain the laws of friction
Explain mechanical efficiency
Apply basic knowledge of physics
Apply basic knowledge of stress, strain, and fatigue
Calculate speed changes

Competency: Describe mechanical power transmission systems

Competency Builders:

Describe the principles and operation of compound and reverted gear trains
Describe the principles and operation of internal and planetary gear trains
Describe the principles and operation of helical and bevel gear trains
Describe the principles and operation of rack and pinion, worm and wheel, and block and screw mechanisms
Describe the principles and operation of counter rotating mechanisms and differentials
Describe the principles and operation of spring mechanisms, pulley blocks and differentials
Describe the principles and operation of chain, belt and disc drives and universal joints
Describe the principles and operation of clutch and coupling mechanisms
Describe the principles and operation of braking mechanisms
Describe the necessity for proper alignment and fit of mechanical devices
Describe the necessity for proper balance of system components
Describe proper component matching (e.g., sheave sets, gear sets)

Competency: Use bearings

Competency Builders:

Define bearing
Identify types of bearings and their applications
Identify installation method
Install bearings
Maintain bearings (e.g., lubrication)
Remove bearings
Identify bearing failure modes

Competency: Use seals

Competency Builders:

Define seal
Identify types of seals and their applications
Identify installation method
Install seals
Maintain seals
Remove seals
Identify failure modes

Competency: Use gears

Competency Builders:

Define gears
Identify types of gears, their materials, and their applications
Identify installation method
Install gears
Maintain gears (e.g., lubrication)
Remove gears
Identify failure modes

Competency: Use sheaves

Competency Builders:

Define sheaves
Identify types, tolerances, and materials of sheaves and their applications
Identify installation method
Install sheaves
Maintain sheaves
Remove sheaves
Identify failure modes

Competency: Use belts and pulleys

Competency Builders:

Define belts and pulleys
Identify types of belts and pulleys and their applications
Identify installation method
Install belts and pulleys
Maintain belts and pulleys
Remove belts and pulleys
Identify failure modes

Competency: Use sprockets and chains

Competency Builders:

Define sprockets and chains
Identify types of sprockets and chains and their applications
Identify installation method
Install sprockets and chains
Maintain sprockets and chains
Remove sprockets and chains
Identify failure modes

Competency: Use cams and levers

Competency Builders:

Define cams and levers
Identify types of cams and levers and their applications
Identify installation method
Install cams and levers
Maintain cams and levers
Remove cams and levers
Identify failure modes

Competency: Use clutches and brakes

Competency Builders:

Define clutches and brakes
Identify types of clutches and brakes and their applications
Identify installation
Install clutches and brakes
Maintain clutches and brakes
Remove clutches and brakes
Identify failure modes

Competency: Install drive components

Competency Builders:

Identify types of couplings and their applications
Install solid coupling
Install jaw coupling
Install molded rubber coupling
Install chain type coupling
Install a clutch
Install brakes
Align bearings, bushing, and cams
Install V-belts and adjust tensions
Install a V-belt and manually adjustable sheaves
Adjust a V-belt and manually adjustable sheaves
Install a V-belt with spring loaded adjustable sheaves
Explain the purposes and advantages of a chain drive system
Explain the function of speed reducers
Explain the function of gears and variable speed reducers
Install shafts
Align shafts
Mount drive sprockets and chains
Mount sheaves and pulleys
Mount gears on open gear drives
Align gears on open gear drives
Install a mechanical clutch system
Install adjustable speed drives
Troubleshoot adjustable speed drives
Explain the operation of fluid couplings
Install fluid couplings
Install torque converters
Perform preventive maintenance on drive components
Inspect completed work
Describe types of fit and tolerances
Explain importance of balance

Competency: **Describe the operation of mechanisms, linkages and levers**

Competency Builders:

Describe class one, two, three, and compound levers
Describe the principles and operation of rocker arm and bell crank linkages and combined mechanisms
Describe the principles and operation of four-bar mechanisms (crank, rocker, and double rocker)
Describe the principles and operation of drag link and intermediate mechanisms
Describe the principles and operation of four-bar variations
Describe the principles and operation of cam mechanisms
Describe the principles and operation of pivoted follower mechanisms
Describe the principles and operation of toggle, quick return, and ratchet mechanisms
Describe the principles and operation of geneva mechanisms

Competency: **Apply knowledge of lubricants**

Competency Builders:

Explain the function of lubricants
Explain the properties of oil lubricants and factors determining the selection of lubricants
Identify types and functions of lubricant additives
Describe types of circulating oils and their purposes
Describe lubricating systems, including the charts and methods used
Demonstrate proper grease application
Demonstrate proper lubricant storage and handling
Lubricate a piece of industrial equipment
Identify specified lubricant or equivalent
Explain lubricant recovery and disposal
Explain use of oil analysis reports

Unit: Electromechanical Technology

Competency: Interpret electromechanical drawings

Competency Builders:

Identify types of drawings and their applications
Transfer measurements
Explain the use of auxiliary views, revolutions, and sectional views
Describe dimensioning practices and techniques on drawings
Interpret mechanical/electronic production and assembly drawings

Competency: Describe the operation of electronic sensors and transducers

Competency Builders:

Explain temperature transducers operation
Explain stress and strain transducers operation
Explain magnetic transducers operation
Explain liquid and fluid flow transducers operation
Explain fiber optic system operation

Competency: **Demonstrate proficiency in transducers (sensors) and instrumentation**

Competency Builders:

Describe characteristics associated with transducers and instrumentation
Describe the principles and operations of various types of transducers (e.g., thermal, shock/vibration, acceleration, positional, pressure, flow, optical, gas and humidity)
Demonstrate the use of various transducers (e.g., thermal, shock/vibration, acceleration, positional, pressure, flow, optical, gas and humidity)
Troubleshoot transducers
Differentiate among thermocouple types
Interpret specifications of temperature sensors (e.g., thermocouples, thermistors, resistance temperature devices)
Interpret specification of pressure sensors (e.g., strain gage, piezzo electric/piezzo resistive) to electrical circuits
Interpret specifications of flow sensors (e.g., orifice flow meter, turbine meter, mass flow meters)
Interpret specifications of speed or position sensor (e.g., tachometer, resolver encoder, linear voltage differential transformer (LVDT)
Interpret specifications of controllers, indicators, and recorders (e.g., process controllers, programmable logic controllers with interfaces, R-chart recorders, dataloggers/indicators)
Interpret specifications of final control elements (i.e., silicon controlled rectifiers (SCR), power controllers, motor drives, actuators/robots)
Describe application circuits
Calculate specification of proximity sensors
Calculate specifications of infrared and photo-sensors
Explain use of proximity sensors
Explain use of photo electric sensors
Explain use of mechanically activated switches
Troubleshoot switch failure
Describe transducer control and measurement circuits
Demonstrate the use of control and measurement circuits
Troubleshoot control and measurement circuits

Competency: **Demonstrate proficiency in power distribution systems**

Competency Builders:

Describe power distribution systems
Describe poly-phase distribution systems
Describe single-phase distribution systems
Describe DC distribution systems
Describe delta distribution systems
Describe wye distribution systems
Describe medium-voltage distribution systems (less than 600v)
Troubleshoot poly-phase distribution systems
Troubleshoot single-phase distribution systems
Troubleshoot DC distribution systems
Troubleshoot delta distribution systems
Troubleshoot wye distribution systems
Troubleshoot medium-voltage distribution systems

Competency: **Demonstrate proficiency in power distribution equipment**

Competency Builders:

Describe power transformers
Describe power capacitors
Describe power oil switches and cutouts
Describe application of NEMA or IEC controls
Describe different types of enclosures for controls
Describe current transformers
Describe potential transformers
Describe medium-voltage circuits breakers and fuses
Use medium-voltage safety equipment
Troubleshoot power transformers
Troubleshoot power capacitors
Troubleshoot power oil switches and cutouts
Troubleshoot current transformers
Troubleshoot potential transformers
Troubleshoot medium-voltage circuit breakers and fuses

Competency: **Demonstrate proficiency in motors and motor contro**

Competency Builders:

Test solid state components with ohmmeter
Test solid state DC motor control circuits
Test solid state AC motor control circuits
Calibrate or recalibrate equipment
Identify SCR and TRIAC AC control circuits
Explain how load is connected to 3-phase wye configured AC generator
Identify wye connected and delta connected 3-phase motors
Explain revolving fields in AC motors
Describe operation of common AC motors
Describe operation of variable frequency AC drives
Define advantages and disadvantages of common DC motors
Explain how motor load affects speed regulation
Describe operation of stepper motors
Describe speed control of various types of motor drives using sensors
Identify defective motors
Describe regenerative dynamic breaking
Describe operation of various feedback loops

Competency: **Apply quality control techniques**

Competency Builders:

Perform preventive maintenance
Demonstrate knowledge of predictive maintenance
Apply statistical process control (SPC)
Recalibrate equipment
Apply problem-solving tools and techniques

Competency: **Apply electromechanical maintenance management practices**

Competency Builders:

Keep maintenance records
Complete work order
Complete internal requisition
Complete external requisition
Explain planned maintenance
Explain breakdown maintenance
Explain predictive maintenance
Establish maintenance schedules
Explain reasons for keeping maintenance records
Explain reasons for keeping cost records
Analyze system failure
Make minor adjustments/repairs
Coordinate maintenance service
Make new/replacement equipment recommendations
Interpret bill of materials for allocation, stocking, and raw material information
Analyze use of bill of materials for workplace decision making

Unit: Precision Machining

Competency: Perform prerequisite machining skills

Competency Builders:

Demonstrate maintenance of immediate work area, machinery, tools and gages
Demonstrate proficiency in interpreting prints/drawings
Demonstrate proficiency in planning work sequence/set up
Follow safety rules and regulations for each machine

Competency: Analyze machine shop jobs

Competency Builders:

Identify sequence of work on specified project(s)
Identify tolerances and finishes on specified project(s)
Identify variables that effect job efficiency (e.g., speeds, feeds)
Use Machinery Handbook
Identify causes of workpiece defects

Competency: Achieve machine shop job standards

Competency Builders:

Write machine shop job procedure
Complete machine shop job status report(s)
Analyze machine shop job evaluation data

Competency: Perform bench operations

Competency Builders:

Use measuring instruments and hand tools
Deburr workpiece
Lay out workpiece
Drill hole
Hand tap hole
Cut threads with die
Apply basic metallurgy knowledge

Competency: Operate metal cutting saw

Competency Builders:

Identify types and uses
Transfer dimensions from blueprint
Clean metal cutting saw
Lubricate metal cutting saw
Install guides
Adjust guides
Select proper blades
Weld saw blade
Install saw blade
Select speeds and feeds
Cut metal
Deburr workpiece
Apply basic metallurgy knowledge
Identify proper cutting fluids

Competency: Operate drill press

Competency Builders:

Clean drill press
Lubricate drill press
Identify proper cutting fluid
Mount part
Select proper bit, speed, and feed
Demonstrate proper bit sharpening techniques
Drill part
Countersink
Tap hole
Apply basic metallurgy knowledge

Competency: Operate tool and cutter grinding machine

Competency Builders:

Identify parts of machine
Identify proper cutting fluids
Identify causes of workpiece defects
Select proper wheels and work holding devices (e.g., superabrasives)
Perform truing operations
Perform dressing operations
Perform forming operations
Select proper speeds and feeds
Sharpen end mill
Sharpen horizontal milling cutter
Sharpen drills and countersinks
Apply basic metallurgy knowledge

Competency: Operate pedestal grinder

Competency Builders:

Clean pedestal grinder
Lubricate pedestal grinder
Identify proper wheel
Identify proper coolant
Check wheel for defects
Mount wheel
Position guard and rest
Dress wheel
Sharpen drill bit
Apply basic metallurgy knowledge

Competency: Operate lathe

Competency Builders:

Clean and lubricate lathe
Deburr
Demonstrate use of a 4-jaw chuck
Identify proper cutting fluid
Identify proper tools and holders
Sharpen tools properly
Mount workpiece
Use dial indicator
Position guards
Select feed(s) and speed(s)
Face workpiece
Turn shaft
Turn taper
Knurl workpiece
Cut off workpiece
Center drill hole
Cut threads (inside and outside)
Turn inside bore
Demonstrate use of steady rest
Demonstrate use of centers
Apply basic metallurgy knowledge

Competency: Operate milling machine

Competency Builders:

Clean milling machine
Lubricate milling machine
Identify proper cutting fluid
Select proper tool
Select proper feeds and speeds
Type of cut (e.g., climb, std.)
Mount workpiece
Mount tool
Mill surface
Mill keyway
Drill workpiece
Bore with milling machine
Mill angle
Apply basic metallurgy knowledge

Competency: Operate surface grinder

Competency Builders:

Clean surface grinder
Lubricate surface grinder
Identify proper cutting fluid
Select proper wheel
Select proper speeds and feeds
Check wheel for defects
Mount wheel
Position guard
Dress wheel
Identify proper mounting techniques
Mount workpiece
Set surface grinder
Apply basic metallurgy knowledge

Competency: Select materials

Competency Builders:

Interpret color codes, numbering systems, and classification systems of materials (i.e., ANSI, SAE)
Identify metals using spark test
Identify metals using variety of tests
Identify materials
Apply basic metallurgy knowledge

Competency: Perform heat treatment and testing of metals

Competency Builders:

Test hardness of metals
Perform non-destructive testing
Perform destructive testing
Harden metals to job specifications
Temper metals to job specifications
Anneal metals to job specifications
Normalize metals to job specifications
Case harden metals to job specifications

Competency: Explain nontraditional machining processes

Competency Builders:

Describe principles of chemical etching
List applications of chemical etching
List advantages/disadvantages of chemical etching
Describe principles of photochemical etching
List applications of photochemical etching
List advantages/disadvantages of photochemical etching
Describe electrical-discharge machining (EDM)
List applications of EDM
Differentiate between EDM and wire EDM
List applications for wire EDM
Describe principles of electrochemical machining
List applications of electrochemical machining
List advantages/disadvantages of electrochemical machining
Describe principles of water jet cutting
List applications of water jet cutting
Describe principles of torch cutting
List applications of torch cutting
Describe principles of laser cutting
List applications of laser cutting
List advantages/disadvantages of laser cutting
Describe shot peen
Describe media finish
Describe glass bead
Describe principles of laser welding

Competency: Perform precision layouts

Competency Builders:

Identify appropriate tools for measuring
Describe precision, accuracy, tolerance, reliability, and discrimination
Distinguish between precision and semiprecision measuring
Define standard stock dimensions and tolerances
Demonstrate knowledge of different units of measure (metric, standard, inches, etc.)
Describe common measurement errors and correction procedures
Calibrate measuring machines and devices
Demonstrate care of measuring instruments
Demonstrate use of rule
Demonstrate use of tape
Demonstrate use of pi tape
Demonstrate use of combination square
Demonstrate use of calipers
Demonstrate use of micrometers (inside and out)
Demonstrate use of dial indicators
Demonstrate use of sine bar
Demonstrate use of gauges (e.g., dial bore, dial snaps)
Demonstrate use of surface plate
Demonstrate use of protractor
Explain use of profilometer
Demonstrate use of thermometer
Demonstrate use of dividers
Demonstrate basic use of gauge blocks
Demonstrate use of threading specs
Explain use of optical comparitor
Explain use of digital instruments
Explain use of electronic gauging equipment
Explain use of data acquisition equipment
Explain operation of manual coordinate measuring machine (CMM)
Explain use and application of laser alignment/measurement

Unit: Fundamentals of Machine Anatomy

Competency: Interpret specifications for a machine

Competency Builders:

Identify power source
Identify power transmission
Identify hydraulic/pneumatic actuators
Identify materials
Identify fits/tolerances
Identify GD&T symbols
Identify safety factors
Participate in concurrent engineering
Demonstrate knowledge of print reading

Competency: Build a machine to specifications

Competency Builders:

Install hydraulic and pneumatic actuators
Troubleshoot hydraulic and pneumatic actuators
Install motors
Troubleshoot motors
Install sensors
Troubleshoot sensors
Install PLC's
Troubleshoot PLC's
Install industrial controls
Troubleshoot industrial controls
Install power distribution systems
Troubleshoot power distribution systems
Install brakes and clutches
Troubleshoot brakes and clutches
Install lubrication system
Troubleshoot lubrication system

Unit: Hydraulics and Pneumatics

Competency: Describe fluid flow concepts

Competency Builders:

Explain Pascal's Law
Explain Boyle's Law
Explain Bernoulli's Principle
Describe flow velocity
Explain how heat and pressure relate to power and transmission
Describe physical and chemical properties of a fluid
Describe fluids in motion in closed conductors
Describe continuity of mass flow
Identify types of fluids
Identify properties of fluids
Identify English and metric units of measurement for pressure, density, and viscosity

Competency: Describe energy considerations

Competency Builders:

Differentiate work and power
Differentiate potential and kinetic energy
Explain energy conservation concept
Explain hydraulic horsepower
Explain work of compression in compressible fluids

Competency: Describe system losses

Competency Builders:

Differentiate turbulent and laminar flow
Explain friction factor
Explain pressure losses
Identify potential system losses (e.g., leaks, wear, component sizing, heat, dirt)

Competency: Describe hydrostatics

Competency Builders:

Explain pressure, density, and viscosity
Explain buoyancy
Explain equilibrium

Competency: Calculate energy

Competency Builders:

Apply Pascal's Law
Apply Bernoulli's Principle
Apply Boyle's Law
Calculate work and power
Calculate potential and kinetic energy
Calculate hydraulic horsepower
Calculate flow velocity and pressure
Calculate pressure losses
Calculate laminar flow
Calculate pump capacity
Calculate system requirements

Competency: Design basic hydraulic/pneumatic system

Competency Builders:

Use common symbols
Create circuit diagrams (i.e., schematics)
Diagram closed-loop hydraulic system
Diagram an air supply system

Competency: Describe component operation

Competency Builders:

Identify functions and operation of hydraulic components
Identify functions and operation of pneumatic components
Explain application(s) of different materials (e.g., plastic, copper)

Competency: Interpret hydraulic and pneumatic schematics

Competency Builders:

Identify common symbols
Sketch circuit diagrams (i.e., schematics)
Interpret circuit diagrams (i.e. schematics)
Sketch circuit analysis
Diagram an air supply system

Competency: Troubleshoot hydraulic and pneumatic circuits

Competency Builders:

Analyze hydraulic circuits
Troubleshoot hydraulic circuits
Analyze pneumatic circuits
Troubleshoot pneumatic circuits

Competency: Perform pump maintenance and repair

Competency Builders:

Identify types and operating features of pumps
Identify pump capacity and system requirements
Explain packing and seal requirements
Explain operating principles of pumps (e.g., centrifugal, propeller and turbine rotary, metering)
Perform pump maintenance
Disassemble a pump
Reassemble a pump

Competency: **Maintain piping and accessories for high and low pressure fluid power systems**

Competency Builders:

Identify components of a piping system
Explain maintenance features of both metallic and non-metallic piping systems
Explain types of values and their operation and maintenance
Explain use and maintenance of strainers, filters, and traps in piping systems
Join common fittings
Join metallic pipe
Join plastic pipe
Join copper and steel tubing
Bend copper and steel tubing
Cut copper and steel tubing
Flare tubing

Competency: **Maintain hydraulic system components**

Competency Builders:

Install a contaminant removal system
Maintain a contaminant removal system
Explain operation and use of heat exchanges
Identify reservoir requirements
Compute hose requirements
Install hydraulic lines
Select control valves and servo-type valves
Install control valves and servo-type valves

Competency: Troubleshoot hydraulic systems

Competency Builders:

Interpret hydraulic schematic
Identify causes of failure modes
Connect electrically controlled valves
Explain hydraulic system troubleshooting techniques
Repair or replace hydraulic valves
Repair or replace hydraulic cylinders
Repair or replace hydraulic pumps and motors
Install hydraulic components

Competency: Describe reciprocating and rotary air compressors

Competency Builders:

Explain relationship of force, weight, mass, and density in pneumatic system
Explain operation of reciprocating compressors
Explain operation of rotary compressors
Explain primary and secondary air treatment (e.g., air dryers, lubricating systems)
Explain operation of compressor valves, cylinders, and motors

Competency: Maintain pneumatic systems

Competency Builders:

Install pneumatic system components
Explain pneumatic system maintenance techniques
Explain pneumatic system troubleshooting procedures
Isolate faults in air compressors
Repair or replace air compressors
Isolate faults in control valves
Repair or replace control valves
Isolate faults in air motors
Repair or replace air motors
Isolate faults in air dryers
Repair or replace air dryers
Maintain proportioning and servo valves

Competency: Troubleshoot pneumatic systems

Competency Builders:

Interpret pneumatic schematic
Diagram an air supply system
Install pneumatic system components
Explain pneumatic system troubleshooting procedures
Troubleshoot air compressors
Troubleshoot pneumatic control valves
Troubleshoot air motors
Troubleshoot air dryers

Competency: **Maintain vacuum systems**

Competency Builders:

Describe characteristics associated with vacuum systems and sub atmospheric pressure
Describe the principles and operation of vacuum gauges
Demonstrate use of vacuum gauges
Repair or replace vacuum gauges
Describe the principles and operation of vacuum pumps
Demonstrate use of vacuum pumps
Repair or replace vacuum pumps
Describe the principles and operation of vacuum controls
Demonstrate use of vacuum controls
Repair or replace vacuum controls

Unit: Industrial Manufacturing Technology

Competency: Describe industrial manufacturing process

Competency Builders:

Demonstrate use and maintenance of personal protective equipment
Explain techniques of measuring motion, forces, voltage, current, power, distance, time and temperature
Explain mechanical and chemical properties of ferrous and non-ferrous metals
Explain industrial manufacturing process
Explain industrial use of non-metallic solids (e.g., ceramics, polymers), liquids, and gases
Develop flow chart and process sheets
Draft preventive maintenance and calibration procedures
Explain need for manufacturing documentation (e.g., ISO 9000)
Define quality process

Competency: Demonstrate knowledge of materials requirements planning

Competency Builders:

Define materials requirements planning
Explain importance of maintaining and controlling inventory (e.g., quantity, price, quality, minimal lot sizes, and timeliness)
Define master production schedule and bill of materials
Explain inventory carrying cost and economic order quantity
Describe the use of the computer in MRP
Calculate net requirements

Competency: Demonstrate knowledge of supply materials

Competency Builders:

Describe role of purchase requisitions
Describe role of material specifications
Describe role of quality parameters
Define supplier certification rating methods
Describe role of source inspector
Describe role of receiving

Competency: Demonstrate knowledge of plant layouts

Competency Builders:

Describe the importance of flexibility
Differentiate among product layout, process layout, fixed position layout, and cellular layout
Describe the type of production suited to each layout
Describe advantages and disadvantages of each layout

Competency: Demonstrate knowledge of material flow

Competency Builders:

Describe importance of flexibility
Differentiate straight-line, U-shaped, S-shaped, convoluted and comb patterns
Describe advantages and disadvantages of each pattern

Competency: Maintain quality control of materials handling

Competency Builders:

Maintain system for physical handling and movement of material in-process and in-storage
Monitor system of physical handling and movement of material in-process and in-storage
Maintain system for physical handling and movement of finished products
Monitor system of physical handling and movement of finished products
Write requests for deviation from specifications
Implement quality control and inspection standards and procedures
Write engineering change notices and rejection reports
Monitor reports of discrepancy or rejects during production process
Conduct quality tests under different environmental conditions

Competency: Demonstrate knowledge of post-production control

Competency Builders:

Explain importance of product protection, identification and storage
Describe methods of identifying products (e.g., labels, bar codes, radio frequency systems and magnetic strip systems)
Describe manual methods of storage and retrieval
Describe automated storage and retrieval systems (ASRS)
Describe automated guided vehicle moving systems (AGVS)

Competency: Analyze a manufacturing project

Competency Builders:

Explain the "how" of project selection
Explain the "how" of project implementation
Explain the "how" of project evaluation
Explain the "how" of planning continuing improvement
Explain the "how" of planning predictive maintenance

Unit: Programmable Logic Controllers (PLCs)

Competency: **Differentiate among process controls**

Competency Builders:

Describe characteristics associated with automatic controls
Define proportional control
Define integral control
Define derivative control
Describe advantages of using proportional, integral or derivative control
Describe disadvantages of using proportional, integral or derivative control

Competency: **Explain basic operation of PLCs**

Competency Builders:

Describe basic applications of PLCs
Identify program symbols and language functions
Describe function of block transfers
Describe operation of timers, counters, and sequences
Describe operation of analog I/O modules
Describe operation of servo motion control
Describe the principles and operation of PLCs

Competency: Demonstrate use of PLCs

Competency Builders:

Draw block diagram of a PLC
Define individual blocks of a PLC
Use operator's and/or manufacturer's manual(s)
Translate relay logic to logic for a PLC
Use function of block transfers
Operate timers, counters and sequencers
Operate analog I/O modules
Operate servo motion control
Install a PLC
Connect controller to sensors
Describe test procedures for new installation of a PLC
Troubleshoot hardware faults on a PLCs
Use safety interlock
Describe use of (Graphic Programmable Panel) GPP
Write a statement and ladder logic program
Document a statement and ladder logic program
Use a PLC program
Troubleshoot a program for a PLC
Repair a program for a PLC

Competency: Apply robot fundamentals

Competency Builders:

Describe the operation of robotic work cells
Operate robotic work cells
Troubleshoot robotic work cells
Repair robotic work cells
Classify robots according to industry criteria
Identify robot power drive types
Describe positioning in terms of axis, actuators and coordinate system
Identify types of control systems and sensors
Apply different methods of programming (e.g., teach, off-line)
Write simple programs to exercise robot functions
Join programs to perform full function
Identify principles of robot safety
Describe operation of various sensors used in robot control
Interface sensors to robot
Interface robots
Define open loop and closed loop control
Design a simple automated system to perform manufacturing operation
Identify operation of end-effectors

Unit: Computerized Numerical Control (CNC)

Competency: **Demonstrate knowledge of CNC**

Competency Builders:

Define numerical control (NC) and computerized numerical control (CNC)
Differentiate NC and CNC
Describe closed loop, open loop, and adaptive controls
Define point to point systems
Identify tool movement of point to point systems
Define continuous path systems
Identify tool movements of continuous path systems
Identify data input mediums
Explain the purpose of the post-processor
Define canned cycles
Identify computer memory types
Identify information stored relative to computer memory types
Differentiate hardware and software
Differentiate among CNC, machining centers, and robots
List advantages/disadvantages of CNC machining centers
Explain direct numerical control (DNC)

Competency: **Perform preventive maintenance**

Competency Builders:

Follow proper safety procedures
Clean CNC equipment
Lubricate CNC equipment
Check CNC equipment for wear and alignment

Competency: Apply CNC operations

Competency Builders:

Identify parts of the machine
Apply basic programming skills to a turning and a milling operation
Select proper work holders
Select proper cutting tools
Set machine parts to drawing tolerances
Use CAD/CAM for part program development

Competency: Prepare CNC program

Competency Builders:

Write a program manually in word address format
Write a program off line
Write a program manually in conversational program
Generate a program using CAD/CAM package
Program machine using manual data input (MDI) process

Competency: Program CNC operations

Competency Builders:

Apply ANSI drawing standards
Apply process planning from drawing to finished product
Analyze workpiece
Contrast differences in computer-assisted programming
Perform basic trigonometric computations
Perform special perception mathematical computations
Set chip load, feed rates and surface feet per minute limitations
Turn intersection points into segments (i.e., defined in terms of points, lines, and circles)
Debug program

Competency: Load machine

Competency Builders:

Load program from MDI and off-line programming station
Prepare work-holding device
Mount work-holding device
Secure workpiece
Set up reference and clearance points
Set up tooling
Select proper lubrication/coolant

Competency: Operate CNC machine

Competency Builders:

Load raw material
Start cycle
Monitor work in-process
Edit CNC programs
Demonstrate ability to halt running program
Apply proper safety procedures
Demonstrate proper cleaning of CNC machine

Competency: Manufacture workpiece (e.g., rectangular, round, angular)

Competency Builders:

Dry-run machine
Run part
Inspect part

Unit: Industrial Engineering Basics

Competency: Apply knowledge of workstation design

Competency Builders:

Participate in development of overall plant layout
Assure minimal movement of materials and parts throughout production line
Plan operator's access to materials and tools
Assure operator never reaches across moving machine part
Eliminate unnecessary body moves (e.g., bends, turns, stoops, hand movements)
Assure physical safety of operator (e.g., equipment, temperature, fumes, light)
List type of material handling equipment for operation
Calculate bench space needs for process and storage
Calculate machine controls to position operator efficiently
Physically simulate operation
Review total process for simplification

Competency: Demonstrate knowledge of ergonomics

Competency Builders:

Define ergonomics
Identify risk factors
Define maximum permissible limit (MPL) and action limit (AL) for lifting
Define cumulative trauma disorder (CTD)
Identify susceptibility factors for CTD
Identify need for mats and footrest for standing jobs
Identify need for appropriate working heights of chairs, stools, workbenches, equipment
Identify need for adequate lighting
Explain use of anthropometric design
Explain use of rest pauses
Minimize extreme joint movement
Minimize use of excessive muscle force
Minimize repetitive tasks
Minimize mechanical stresses (e.g., sharp edges, heat, cold, hard surfaces, weights, vibration)
Minimize awkward body positions

Competency: Apply knowledge of methods engineering

Competency Builders:

Define methods engineering
Define goals of methods engineering (i.e., quality, increase productivity, decrease per unit cost)
Set sequence of production operations
Set sequence of needed inspections
Recommend methods to shorten process time
Recommend alternate operations
Recommend ways to eliminate operations
Ascertain if operations can be performed within facilities
Test machine capability
Follow documentation procedures

Competency: Apply knowledge of standards engineering

Competency Builders:

Estimate times by computer simulation
Use predetermined time system (e.g., MTM family)
Use work sampling
Define reach, grasp, move position, turn, apply pressure, and release
Define standard time
Define performance rating
Define allowances
Identify leveling factors (e.g., skill levels, effort, work area conditions, consistency)
Identify allowance factors (e.g., fatigue, delay, personal)
Calculate production rate
Write job description data
Complete job status reports
Analyze job evaluation data

Unit: Basic Materials Science

Competency: Demonstrate basic knowledge of metallurgy

Competency Builders:

Define metallurgy
Define metal forming (e.g., general process)
Identify forming industries (e.g., stamping, forging, fabricating)
Describe metal forming principles
Describe the metal forming process
Identify frequently used metals
Describe the crystalline structures of metals
Use periodic chart to evaluate metals
List chemical properties of common metals
List physical properties of common metals
Describe measures of metal strength
Identify examples of raw materials processed by hot rolling, cold rolling, forging, drawing, extrusion, spinning and powered metallurgy
Explain secondary finishing operations (e.g., paint, anodizing)

Competency: Demonstrate basic knowledge of heat treatment

Competency Builders:

Describe process of heat treating
Define types of heat treating (e.g., case hardening, annealing, drawing, stress relieving, tempering, quenching, critical temperature)

Competency: **Demonstrate basic knowledge of metal characteristics and formability**

Competency Builders:

Explain metal and formability basics
Explain metal grades and coatings
Explain part contour analysis
Explain tensile test
Explain LDH test
Explain bend test
Explain hold expansion test
Explain R-value test
Explain hardness test
Explain cup test
Explain friction test
Explain surface test
Explain interpretation of metal characteristics tests
Describe blank/die interactions (e.g., friction)
Describe friction and forming process
Describe circle grid basics
Describe circle grid applications
Describe formability diagnostics
Describe the documentation process

Competency: **Demonstrate basic knowledge of casting**

Competency Builders:

Identify frequently used metals
Describe crystalline structures of metals
Use periodic chart in evaluating metals
List chemical properties of common metals
List physical properties of common metals
Define permanent mold casting
Define shell mold casting
Define sand casting and pattern making
Define die casting
Identify basic casting terms
Identify advantages/disadvantages of casting processes

Competency: **Demonstrate basic knowledge of iron and its alloys**

Competency Builders:

Define iron and its alloys
Describe iron manufacturing process
Describe the structure of iron and its alloys
List chemical properties of iron and its alloys
List physical properties of iron and its alloys
Describe iron and alloys property variables
Describe measures of strength for iron and its alloys
Identify examples of iron and its alloys processed by hot rolling, stamping, cold rolling, drawing, extrusion, spinning, casting, forging and machining
Perform tensile test
Perform Brinell test
Perform chemical analysis

Competency: **Demonstrate basic knowledge of aluminum and its alloys**

Competency Builders:

Define aluminum and its alloys
Describe aluminum manufacturing process
Describe the structure of aluminum
List chemical properties of aluminum
List physical properties of aluminum
Describe aluminum property variables
Identify examples of aluminum processed by cold rolling, drawing, extrusion, stamping, spinning, casting, forging and machining
Perform tensile test
Perform Brinell test
Perform chemical analysis

Competency: **Demonstrate basic knowledge of copper and its alloys (e.g., brass, bronze)**

Competency Builders:

Define copper and its alloys
Describe copper manufacturing process
Describe the structure of copper
List chemical properties of copper
list physical properties of copper
Describe copper property variables
Describe measures of copper strength
Identify examples of copper processed by cold rolling, drawing, extrusion, stamping, spinning, casting, forging and machining
Perform tensile test
Perform Brinell test
Perform chemical analysis

Competency: **Demonstrate basic knowledge of plastics and polymers**

Competency Builders:

Define thermo-analysis testing (e.g., melt flow, moisture control)
Define plastics and polymers
Describe plastics and polymers manufacturing processes
Describe structure of plastics and polymers
List chemical properties of plastics and polymers
List physical properties of plastics and polymers
Differentiate thermoset and thermoplastic
Describe plastics and polymer property variables
Describe measure of plastic and polymer strength
Identify examples of raw materials processed by machining, extrusion, stamping, injection molding, compression molding and injection compression molding
Identify molding defect (e.g., flash, sink marks, warp, contamination, wet material, stuck parts, short shot, burn marks, surface blemishes)
Identify secondary operations performed on plastic parts (e.g., plating, milling, painted)
Perform tensile test
Perform R-value test

Competency: **Demonstrate basic knowledge of concrete and other ceramics**

Competency Builders:

Explain concrete tools and applications (e.g., float, chairs)
Describe the formation of concrete
List types of cements and their uses
Define qualities of concrete (i.e., strength, consistency, homogeneity, tensile force, abrasion, heat of hydration, and heat and sulfate resistance)
List tests used in concrete production (e.g., slump test, test of fineness modules)
List protective practices used after pouring

Competency: **Demonstrate knowledge of corrosion and protection**

Competency Builders:

Identify causes of corrosion
Identify types of corrosion
List solutions to minimize problems
Identify corrosion testing

Competency: **Demonstrate basic knowledge of rubber manufacturing**

Competency Builders:

Explain history of rubber industry
Compare properties of natural rubber with those of synthetic rubber
Explain how natural rubber is manufactured
Explain vulcanizaton, mastication, and cure systems
Explain use of compounding ingredients (e.g., carbon blacks, accelerators, fillers, antioxidants)
Explain press and autoclave curing
Explain how synthetic rubber is manufactured (e.g., neoprene, butyl, styrene-butadiene)
Explain rubber testing (e.g., tensile, durometer)

Unit: Welding Basics

Competency: Perform basic gas welding, brazing, and cutting

Competency Builders:

Follow safety guidelines
Differentiate welding and brazing
Identify gas welding and cutting equipment and accessories
Use personal protective equipment required for welding and cutting
Explain capillary attraction as it applies to metal
Demonstrate proper lighting, adjusting, and shutting down of gas torch
Layout mild steel
Cut mild steel
Braze mild steel
Solder non-ferrous metals
Apply basic metallurgy technology

Competency: Perform basic arc welding/cutting (i.e., stick)

Competency Builders:

Identify arc welding equipment and accessories
Explain process of resistance welding
Explain process of projection welding
Explain process of flash-butt welding
Explain process of laser welding
Explain process of friction welding
Explain process of spot welding
Explain process of shielded metal-arc welding (SMAW)
Explain process of gas metal-arc welding (GMAW)
Explain process of gas tungsten-arc welding (GTAW)
Explain process of plasma-arc cutting
Explain process of carbon arc gouging and cutting
Explain process of welding plastics
Explain welding rod alloys
Read welding rods
Explain mild steel welding rod
Explain low hydrogen welding electrode
Explain rationale for preheating and post-heating metal
Explain (GMAW) welding in flat, horizontal, vertical positions
Explain (GTAW) welding on mild steel, stainless steel, and aluminum
Explain process of build up and hard facing
Troubleshoot fusion of materials
Weld stainless steel using (SMAW) process
Weld steel requiring preheat
Weld cast iron
Weld aluminum
Apply basic metallurgy technology

Unit: Metal Stamping Dies

Competency: Describe different types of dies

Competency Builders:

Describe crimping die
Describe parts assembly die
Describe CAM bending die
Describe blanking die
Describe pierce die
Describe forming die
Describe draw die
Describe progressive die

Competency: Describe fixtures

Competency Builders:

Describe crimping fixture
Describe locating fixture
Describe press fitting fixture
Describe riveting fixture
Describe welding fixture

Competency: Design product

Competency Builders:

Draw isometric view of product
Construct model (e.g., clay, form, wood, plastic)
Scan model
Wire frame data
Create computerized model
Interface model with CAD/CAM
Reproduce surface finish
Identify materials for product
Create prototype
Validate product
Standardize product

Competency: Troubleshoot design errors

Competency Builders:

Isolate cause of die component breakage
Isolate cause of failure of parts to be removed from die
Isolate cause of incorrect punch clearance
Isolate cause of incorrect die clearance
Isolate cause of misfitting die components

Competency: Correct design errors

Competency Builders:

Correct cause of die component breakage
Correct cause of failure of parts to be removed from die
Correct cause of improper punch clearance
Correct cause of improper die clearance
Correct cause of misfitting die components

Competency: Explain die processing

Competency Builders:

Describe preplanning activities
Describe die layout
Identify die operations (e.g., number, purpose and sequence of die operations)
Describe feasibility study development
Describe sequence of operations from die construction

Competency: Explain pattern shop applications

Competency Builders:

Describe pattern shop activities
Describe die pattern materials (e.g., wood, styrofoam, ceramic)
Describe die pattern construction
Describe casting of dies
Describe casting of components
Describe model process steps
Describe model use

Competency: Explain die construction (e.g., production and operation techniques)

Competency Builders:

Explain need for basic machining skills
Explain need for sculptured machining skills
Explain EDM functions
Explain die material standards
Describe tool and die welding
Describe punch finishing
Explain lifter/gauging systems
Explain pressure systems
Describe function of cams

Competency: Explain the die tryout process

Competency Builders:

Explain need to use analytical problem solving for die tryout
Describe process documentation
Describe die modification techniques
Describe blank modification techniques
Describe die buy-off
Describe die release
Describe part release
Describe die coatings
Describe die treatments

Competency: Explain die maintenance

Competency Builders:

Describe planned die maintenance
Describe predictive die maintenance
Describe preventive die maintenance
Describe die maintenance troubleshooting techniques
Describe die refurbishment techniques

Unit: Press Technology

Competency: Explain press operation

Competency Builders:

Identify types of presses
Describe functions of presses
Identify capacity of presses
Describe shuttheight
Identify operator safety devices

Competency: Demonstrate knowledge of press accessories

Competency Builders:

Describe function of monitors, proximity switches and die protection
Describe function of loaders
Describe function of roller levelers
Describe function of decoilers
Describe function of feeders
Describe function of transfer mechanisms
Describe function of lubricators and coolants
Describe processing of coil steel
Describe use of quick die change
Describe press set-up

Unit: Sheet Metal Fabrication

Competency: Demonstrate knowledge of sheet metal fabrication

Competency Builders:

Describe sheet metal fabricated products
Describe press working process
Describe process(es) of straightening metal
Describe metal finishing and coating
Explain bend allowances
Identify materials used for sheet metal fabricaton (e.g., hot roll, cold roll, aluminum, stainless)
Explain process of determining metal thicknesses
Explain process of layout
Explain process of fastening
Explain process of punch and die clearance and alignment
Demonstrate the capability to finish (cleaning, painting, plating)
Demonstrate CADD uses for layout

Competency: Describe types of metal fabrication manufacturing

Competency Builders:

Describe shear
Describe press brake
Describe cut-to-length lines
Describe roll forming
Describe CNC turret presses
Describe FMS cells

Competency: Layout sheet metal

Competency Builders:

Lay out 90° ells
Lay out 45° and 30° ells
Use radial line development to lay out
Use development by triangulation to lay out

Competency: Fabricate components

Competency Builders:

Layout design
Measure materials
Create pattern and/or prototype
Use hand tools
Cut materials
Form materials
Use fasteners
Spot weld

Competency: Perform sheet metal fabrication

Competency Builders:

Identify sheet metal fabrication jobs
Identify tools (e.g., manual and hand powered) needed
Fabricate round ells
Fabricate tees
Fabricate pyramids
Fabricate cones
Fabricate square to round transitions

TECH PREP

"GET SERIOUS . . . ABOUT SUCCESS"

Manufacturing (Industrial) Technician

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—NOTICE—

Each Tech-Prep Competency Profile developed should respond to the labor market demands of your Tech Prep Consortium. Therefore, the following pages should be examined carefully before being selected for use in TCP Part I. **[See "The TCP Process" for more information.]** For example, in some cases the number of units far exceeds the amount of content that can be covered within a 4 + 2 TPAD Program. All the units listed in this section will not necessarily apply to your situation, nor will all the competencies within each unit be appropriate. Note that several units appear within each specific occupation and would need to only appear once if you are compiling a cluster of occupations. **[See "TCP Matrix" and "How to Use the TCP Binder" for more information.]**

Unit: Communications Literacy

NOTE: This content was extracted from the 9-12 cluster of Ohio's Model Language Arts Program. Due to statewide initiatives other than Tech Prep, this literacy unit was not altered to meet competency-based criteria. Each literacy unit forms a critical link between academic teachers and members of business, industry, and labor. [See "The TCP Process" for more information.]

Subunit: Reading—Structure

Competencies:

RS1 Exhibit knowledge of language structure
RS2 Recognize that there may be more than one interpretation of reading selections
RS3 Recognize various literary devices
RS4 Recognize and discuss literary elements
RS5 Develop and use an increasingly sophisticated vocabulary gained through context
RS6 Apply knowledge of language structure to reading
RS7 Explain why there may be more than one interpretation of reading selections
RS8 Recognize effect of literacy devices on meaning
RS9 Analyze author's use of literary elements
RS10 Recognize relationship of structure to meaning
RS11 Describe various interpretations and meaning levels in reading selections
RS12 Characterize author's use of literary devices
RS13 Characterize use of literary techniques
RS14 Critique a variety of literature with regard to plot, dialogue, theme, setting, and characterization
RS15 Apply an expanding vocabulary gained through reading
RS16 Explain various interpretations and meaning levels in reading selections
RS17 Analyze use of literary techniques (e.g., extended metaphor, simile, personification, hyperbole, pun, alliteration)
RS18 Understand use of literary devices (e.g., irony, satire, allegory, onomatopoeia)
RS19 Analyze and synthesize pieces of literature with regard to plot, dialogue, theme, setting, and characterization

Subunit: Reading—Meaning Construction
Competencies:

RM1	Demonstrate ability to recognize appropriate pre-reading strategies
RM2	Describe effectiveness of a reading selection
RM3	Read to clarify personal thinking and knowledge
RM4	Support interpretation of text by locating and citing specific information
RM5	Develop personal response to a variety of literary works
RM6	Recognize diverse literary interpretations
RM7	Engage in self-selected reading activities
RM8	Confirm and extend meaning in reading by researching new concepts and facts
RM9	Self-monitor and apply corrective strategies when communication has been interrupted or lost
RM10	Use features of literary genres to extend meaning
RM11	Assess effectiveness of a selection read
RM12	Use reading as a possible problem-solving strategy to clarify personal thinking and knowledge
RM13	Use knowledge of semantic elements (e.g., figurative language, denotation, connotation, dialect) to clarify meaning when reading
RM14	Predict, recognize, interpret, and analyze themes based on familiarity with author's work
RM15	Compare and contrast literary genres
RM16	Assess validity and quality of selection read
RM17	Clarify meaning when reading
RM18	Compare personal reaction to critical assessment of a literary selection
RM19	Assess validity of diverse literary interpretations
RM20	Use reference books to find, evaluate, and synthesize information
RM21	Identify tone of a literary work
RM22	Critique validity of diverse literary interpretations
RM23	Integrate personal reaction to and critical assessment of a literary selection

Subunit: Reading—Application
Competencies:

RA1	Select and read material for personal enjoyment and information
RA2	Read a variety of complete, unabridged works
RA3	Employ various reading strategies according to purpose
RA4	Participate in selection of books, materials, and topics for literature study groups
RA5	Develop and apply knowledge of the interrelationship of concepts
RA6	Read selections from a variety of styles and formats, recognizing that style and format influence meaning
RA7	Extend value of reading, writing, speaking, viewing, and listening by pursuing, through reading, new concepts and interests developed as a result of these activities
RA8	Read extensively from a particular author's work and explain elements
of	author's style

Subunit: Reading—Multidisciplinary
Competencies:

RM1	Connect themes and ideas across disciplines through literature
RM2	Read to facilitate learning across curriculum
RM3	Read to develop awareness of human rights and freedom
RM4	Participate actively in a community of learners
RM5	Recognize and explain interaction between literature and various cultural domains (e.g., social technological, political, economic)
RM6	Explore and analyze a variety of cultural elements, attitudes, beliefs, and value structures by men and women of many racial, ethnic, and cultural groups
RM7	Value thinking and language of others
RM8	Relate literature to historical period about which or in which it was written
RM9	Read to facilitate content learning

Subunit: Writing—Structure
Competencies:

WS1	Develop and expand a repertoire of organizational strategies (e.g., narration, comparison/contrast, and description) through a practice and discussion
WS2	Clarify word choice according to audience, topic, and purpose
WS3	Locate and correct errors in usage, spelling, and mechanics using a variety of resources
WS4	Recognize information gained from primary and secondary sources
WS5	Develop writing which contains ordered, related, well-developed paragraphs with sentences of varied lengths and patterns
WS6	Use information from a variety of sources to develop an integrated piece of writing
WS7	Evaluate and revise writing to focus on such things as audience, tone, and purpose
WS8	Recognize differences between documentation and reference list styles
WS9	Develop extended pieces of writing which contain ordered, related, well-developed paragraphs with sentences of varied lengths and patterns
WS10	Select from a repertoire of organization strategies a pattern appropriate to a topic
WS11	Synthesize information from a variety of sources
WS12	Refine word choice and tone according to audience, situation, and purpose
WS13	Appropriately cite information gained from primary and secondary sources
WS14	Use style manuals or software to prepare documentation and reference lists
WS15	Develop effectively organized pieces of expository writing containing strong voice, clear thesis, and well-developed ideas
WS16	Identify organization patterns appropriate to writing topic
WS17	Respond to others' suggested revisions to a writing piece

Subunit: Writing—Meaning Construction
Competencies:

WM1 Demonstrate knowledge of the recursive nature of the writing process by applying it appropriately to various topics, situations, and audiences
WM2 Develop criteria for writing evaluation using scoring guides and peer/teacher assistance to clarify meaning
WM3 Respond to others' suggested revisions to a piece of writing
WM4 Use word processing, graphics, and publishing aids to construct meaning in writing
WM5 Engage in self-initiated writing activities
WM6 Incorporate personal criteria with generally accepted standards for writing evaluation
WM7 Evaluate, analyze, and synthesize information for writing
WM8 Evaluate own writing using personal and established scoring criteria
WM9 Assess personal/peer revisions to a writing piece
WM10 Recognize and refine personal writing styles

Subunit: Writing—Application
Competencies:

WA1 Apply appropriate writing techniques suitable for varied writing tasks
WA2 Use sentence-combining techniques to improve syntactic fluency and maturity
WA3 Write in response to prompted and self-selected topics in practical, persuasive, descriptive, narrative, and expository domains
WA4 Develop personal voice in writing
WA5 Consider audience and purpose for writing
WA6 Develop criteria for selection and potential development of topic
WA7 Write in a journal or learning log to clarify personal thinking and knowledge
WA8 Apply an expanding vocabulary gained through writing
WA9 Make judicious use of reference sources (e.g., dictionary, thesaurus, on-lien data base, encyclopedia)
WA10 Demonstrate, an appreciation for aesthetically pleasing language through word choice and style
WA11 Apply revising and editing strategies needed for writing task
WA12 Vary sentence lengths and patterns
WA13 Refine personal voice in writing
WA14 Vary styles and formats for intended purpose and audience
WA15 Apply criteria for selection and development of topic
WA16 Participate in peer review of writing in progress
WA17 Use transitions between sentences, ideas, and paragraphs in writing
WA18 Revise and edit papers extensively in preparation for presentation/publication
WA19 Develop a variety of genres
WA20 Focus writing and tone on such elements as audience, situation, and purpose
WA21 Develop topic fully and appropriately
WA22 Use writing process to clarify personal thinking and knowledge
WA23 Apply appropriate recursive writing process as suggested by writing task and writer's process
WA24 Develop an extended piece of writing
WA25 Revise writing and tone to assure focus on such elements as audience, situation, and purpose
WA26 Use writing process to write reflectively

Subunit: Writing—Multidisciplinary

Competencies:

WM1	Use writing process for learning across curriculum
WM2	Use writing process to demonstrate knowledge of need for human rights and freedom
WM3	Value and apply collaborative skills in writing process
WM4	Write in response to reading, speaking, viewing, and listening
WM5	Use multidisciplinary resources in writing projects
WM6	Use writing process to facilitate learning across curriculum
WM7	Recognize value of and engage in collaboration in writing process
WM8	Use communication processes to develop a published writing piece in collaboration with others
WM9	Record experiences and observations related to content learning
WM10	Apply collaborative skills in writing process
WM11	Write collaboratively with peers
WM12	Use cross-disciplinary resources in writing projects

Subunit: Listening/Visual Literacy—Structure

Competencies:

LS1	Listen to and view a wide variety of genres
LS2	Become aware of an author's style through listening and viewing a variety of works
LS3	Recognize correct and appropriate grammar, diction, and syntax
LS4	Expand vocabulary through listening to and viewing varied media
LS5	Recognize beauty of language
LS6	Enhance recognition of an author's style through listening and viewing a variety of works
LS7	Recognize use and misuse of language in media
LS8	Refine knowledge of style through listening and viewing multiple works by the same author
LS9	Expand and refine grammar, diction, and syntax through listening
LS10	Compare authors' styles through viewing and listening to their works
LS11	Expand knowledge of complex grammar, diction, and syntax issues

Subunit: Listening/Visual Literacy—Meaning Construction
Competencies:

LM1 Develop critical thinking skills necessary to evaluate media and assess oral presentations
LM2 Compare new oral texts to past experiences and knowledge in order to enhance comprehension
LM3 Recognize how rhythmic patterns, silence, and cadences enhance quality of speech and literature
LM4 Focus listening and viewing on themes and/or plots
LM5 Gather information from listening and viewing experiences to enhance research
LM6 Use critical thinking skills to evaluate media and oral presentations
LM7 Use prior knowledge and experiences to facilitate comprehension of new oral texts
LM8 Identify rhythmic and time patterns in speech and literature
LM9 Identify and analyze themes and/or plots when listening and viewing
LM10 Use information gathered from listening and viewing experiences to expand research
LM11 Enhance use of critical thinking skills to evaluate media and oral presentations
LM12 Consider prior knowledge and experiences when attempting to understand the meaning of new texts
LM13 Appreciate rhythmic and time patterns of speech and literature
LM14 Select viewing and listening materials to support written text
LM15 Evaluate media and oral presentations analytically and critically
LM16 Organize prior knowledge and experiences to comprehend new texts
LM17 Organize and use viewing and listening materials to support written text

Subunit: Listening/Visual Literacy—Application
Competencies:

LA1 Listen attentively during oral reading
LA2 Use media as stimuli for learning and thinking
LA3 Develop knowledge of structure through art, music, and literature
LA4 Use electronic media to enhance and highlight language learning
LA5 Listen and view for entertainment and enjoyment
LA6 Use technology and other media as means of expressing ideas

Subunit: Listening/Visual Literacy—Multidisciplinary

Competencies:

LM1	Facilitate learning across curriculum through critical listening and viewing
LM2	Engage in individual, small-group, and whole-group listening and viewing activities
LM3	Develop language arts (e.g., viewing, listening) projects collaboratively
LM4	Investigate language and cultural differences through listening and viewing activities
LM5	Participate in a community of learners through productive listening

Subunit: Oral Communication—Structure

Competencies:

OS1	Refine oral communication skills
OS2	Demonstrate knowledge of grammar, usage, and syntax when presenting
OS3	Select topics and vocabulary suitable to audience
OS4	Organize notes and ideas for speaking
OS5	Use language imaginatively
OS6	Modulate voice to meaning when interpreting literature orally
OS7	Organize notes and ideas for formal, semiformal and informal presentations of information
OS8	Refine speaking techniques for formal, semiformal, and informal settings
OS9	Develop repertoire of organizational strategies for presenting information orally
OS10	Expand vocabulary to fit topic
OS11	Select topics suitable to audience, situation, and purpose
OS12	Select appropriate strategies when organizing notes and ideas for speaking

Subunit: Oral Communications—Meaning Construction
Competencies:

OM1	Make connections between prior knowledge and new information for oral presentations
OM2	Participate in informal speaking activities
OM3	Use interviewing techniques to gather information
OM4	Communicate orally to entertain and to inform
OM5	Participate in group communication activities
OM6	Take and organize notes when preparing speech/presentation
OM7	Interpret texts orally to illustrate meaning
OM8	Respond to needs of various audiences
OM9	Gather and assess information for speaking
OM10	Communicate orally to inform and persuade
OM11	Prepare and deliver formal speech/presentation
OM12	Participate in a variety of oral interpretations
OM13	Assess needs of audience and adjust language and presentation according to their knowledge
OM14	Analyze and synthesize information for speaking
OM15	Describe effectiveness of literary selection
OM16	Describe topic or idea in order to clarify personal/audience thinking
OM17	Analyze and synthesize information gathered from a variety of sources for speaking
OM18	Describe validity and/or quality of a literary selection and justify selection
OM19	Interpret orally a variety of literature
OM20	Describe topic or idea to clarify meaning for others

Subunit: Oral Communication—Application
Competencies:

OA1	Become proficient at using interviewing techniques
OA2	Give an oral interpretation for a specific audience
OA3	Develop and apply oral communication skills for cooperative/collaborative learning
OA4	Use oral communication for a variety of purposes and audiences (e.g., negotiations, book reviews, rationales)
OA5	Develop and apply decision-making strategies
OA6	Practice interviewing techniques
OA7	Apply interviewing techniques to purposeful interviews
OA8	Focus oral interpretation on a specific audience

Subunit: Oral Communications—Multidisciplinary

Competencies:

OM1	Value thinking and language of others
OM2	Develop oral projects collaboratively
OM3	Be involved in individual, small-group, and whole-group language activities
OM4	Participate actively in a community of learners
OM5	Investigate language and cultural differences through oral language activities

Unit: Mathematics Literacy

NOTE: This content was extracted from the 9-12 cluster of Ohio's Model Mathematics Program. Due to statewide initiatives other than Tech Prep, this literacy unit was not altered to meet competency-based criteria. Each literacy unit forms a critical link between academic teachers and members of business, industry, and labor. [See "The TCP Process" for more information.]

Subunit: Numbers and Number Relations

Competencies:

NR1	Compare, order, and determine equivalence of real numbers
NR2	Estimate answers, compute, and solve problems involving real numbers
NR3	Compare and contrast real number system, rational number system, and whole number system
NR4	Extend knowledge to complex number system and develop facility with its operation

Subunit: Measurement

Competencies:

M1	Estimate and use measurements
M2	Understand need for measurement and probability that any measurement is accurate to some designated specification
M3	Understand and apply measurements related to power and work
M4	Understand and apply measurement concepts of distance-rate-time problems and acceleration problems
M5	Use real experiments to investigate elasticity, heat, sound, electricity, magnetism, light, acceleration, velocity, energy, and gravity
M6	Use real-world problem situations involving mass and weight
M7	Use real-world problem situations involving simple harmonic motion
M8	Establish ratios with and without common units
M9	Construct and interpret maps, tables, charts, and graphs as they relate to real-world mathematics
M10	Understand and solve rate-change problems
M11	Understand and solve right triangle relationships as they relate to measurement, specifically to Pythagorean theorem
M12	Graph and interpret ordered pairs
M13	Compute total sales from a variety of items
M14	Comprehend and compute rates of growth or decay
M15	Comprehend, compute, and interpret real problems involving annuities

Subunit: Measurement (continued)
Competencies:

M16 Develop an ability to identify real problems and provide possible solutions
M17 Express and apply different types of measurement scales
M18 Identify area and volume

Subunit: Estimation and Mental Computation
Competencies:

E1 Use estimation to eliminate choices in multiple-choice tests
E2 Use estimation to determine reasonableness of problem situations in a wide variety of applications
E3 Estimate shape of graphs of various functions and algebraic expressions
E4 Use mental computation when computer and calculator are inappropriate

Subunit: Data Analysis and Probability
Competencies:

D1 Organize data into tables, charts, and graphs
D2 Understand and apply measures of central tendency, variability, and correlation
D3 Use curve fitting to predict from data
D4 Use experimental or theoretical probability, as appropriate, to represent and solve problems involving uncertainty
D5 Use computer simulations and random number generators to estimate probabilities
D6 Test hypotheses using appropriate statistics
D7 Read, interpret, and use tables, charts, and graphs to identify patterns, note trends, draw conclusions, and make predictions
D8 Identify probabilities of events involving unbiased objects
D9 Use sampling and recognize its role in statistical claims
D10 Design a statistical experiment to study problem, conduct experiment, and interpret and communicate outcomes
D11 Describe normal curve in general terms and use its properties
D12 Create and interpret discrete probability distributions
D13 Understand concept of random variable
D14 Apply concept of random variable to generate and interpret probability distributions, including binomial, uniform, and chi square

Subunit: Algebra
Competencies:

A1 Describe problem situations by using and relating numerical, symbolic, and graphical representations
A2 Use language and notation of functions in symbolic and graphing settings
A3 Recognize and use equivalent zeros of a function, roots and the solution of an equation in terms of graphical and symbolic representations
A4 Describe and use logic of equivalence in working with equations, inequalities, and functions
A5 Develop graphical techniques of solution for problem situations involving functions
A6 Explore and describe characterizing features of functions
A7 Make arguments and proofs in algebraic settings
A8 Factor difference of two squares
A9 Identify slope, midpoint, and distance
A10 Explore and combine rational functions
A11 Explore factoring techniques
A12 Solve quadratic equations by factoring and formula
A13 Set up and solve linear equations
A14 Solve systems of linear equations with two variables
A15 Describe geometric situations and phenomena using variables, equations, and functions
A16 Describe measures of central tendency, mean, median, mode, and variance algebraically and graphically
A17 Represent inequalities on number line and in coordinate plane
A18 Use coordinate arguments in making geometric proofs
A19 Symbolize transformations of figures and graphs
A20 Explore geometric basis for functions of trigonometry
A21 Graph linear functions
A22 Develop and use vectors to represent direction and magnitude including operations
A23 Use polar and parametric equations to describe, graph, and solve problem situations
A24 Represent sequences and series as functions both algebraically and graphically
A25 Explore recursive functions and procedures using spreadsheets, other computer utilities, and appropriate notions
A26 Describe and solve algebraic situations with matrices
A27 Describe and use inverse relationship between functions including exponential and logarithmic

Subunit: Algebra (continued)
Competencies:

A28	Analyze and describe errors and error sources that can be made when using computers and calculators to solve problems
A29	Decide whether problem situation is best solved using computer, calculator, paper and pencil, or mental arithmetic/estimation techniques
A30	Explore relationships between complex numbers and vectors
A31	Make arguments concerning limits, convergence and divergence in context involving sequences, series, and other types of functions
A32	Represent transformations in plane with matrices
A33	Contrast and compare algebra's of rational, real, and complex numbers with characteristics of a matrix algebra system
A34	Construct polynomial approximations of a function over specified intervals of convergence
A35	Examine complex numbers as zeros of functions
A36	Translate verbal statements into symbolic language
A37	Simplify algebraic expressions
A38	Use laws and exponents (including scientific notation)
A39	Expand and extend idea of vectors and linear algebra to higher dimensional situations
A40	Use the idea of independent basis elements for a vector space and associated fundamental concepts of finite dimensional linear algebra
A41	Develop and communicate arguments about limit situations
A42	Use matrices to describe and apply transformations
A43	Develop and use polar and parametric equations to represent problem situations
A44	Explore proofs by mathematical induction

Subunit: Geometry
Competencies:

G1 Create and interpret drawings of three-dimensional objects
G2 Represent problem situations with geometric models and apply properties of figures
G3 Apply Pythagorean theorem
G4 Demonstrate knowledge of angles and parallel and perpendicular lines
G5 Explore inductive and deductive reasoning through applications to various subject areas
G6 Translate between synthetic and coordinate representations
G7 Identify congruent and similar figures using transformation with computer programs
G8 Deduce properties of figures using transformations and coordinates
G9 Use deductive reasoning
G10 Explore compass and straightedge constructions in context of geometric theorems
G11 Demonstrate knowledge of and ability to use proof
G12 Use variety of proof techniques (e.g., synthetic, transformational, and coordinate)
G13 Use variety of proof formats, including T-proof (i.e., two-column) and paragraph proof
G14 Explore different proof strategies
G15 Investigate different proofs of theorems
G16 Develop knowledge of an axiomatic system
G17 Apply transformations and coordinates in problem solving
G18 Represent problem situations with geometric models and apply properties of figures
G19 Deduce properties of figures using vectors
G20 Analyze properties of Euclidean transformations and relate translations to vectors
G21 Apply vectors in problem solving
G22 Develop further knowledge of axiomatic systems by investigating and comparing various geometry's

Subunit: Patterns, Relations, and Functions
Competencies:

P1	Model real-world phenomena with polynomial and exponential functions
P2	Explore relationship between zeros and intercepts of functions
P3	Translate among tables, algebraic expressions, and graphs of functions
P4	Use graphing calculator or computer to generate graph of a function
P5	Explore relationship between a linear function and its inverse
P6	Describe and use characteristics of polynomial functions in problem-solving situations
P7	Explore conic sections and graph using graphing calculator or computer
P8	Apply trigonometric functions to problem situations involving triangles
P9	Discover relationships between algebraic description, kind, and properties of conic
P10	Explore periodic real-world phenomena using sine and cosine functions
P11	Analyze effects of parameter changes on graphs
P12	Use graphing calculator or computer to graph functions
P13	Develop an knowledge of rational and transcendental functions
P14	Understand connections between trigonometric and circular functions
P15	Use circular functions to model periodic real-world functions
P16	Solve trigonometric equations and verify trigonometric identities
P17	Understand connections between trigonometric, exponential, and logarithmic functions and polar coordinates, complex numbers, and series
P18	Model real-world phenomena with a variety of functions
P19	Graph using polar coordinates
P20	Explore graphs in three dimensions
P21	Explore functions of several variables
P22	Explore recursive functions using spreadsheets and/or programming languages

Unit: Science Literacy

NOTE: This content was extracted from the 9-12 cluster of Ohio's Draft Model Science Program. Due to statewide initiatives other than Tech Prep, this literacy unit was not altered to meet competency-based criteria. Each literacy unit forms a critical link between academic teachers and members of business, industry, and labor. [See "The TCP Process" for more information.]

Subunit: Scientific Inquiry

Competencies:

Q1 Check the appropriateness and accuracy of measures and computations using various strategies (e.g., estimations, unit analysis, determination of significant figures)
Q2 Use ratios, proportions, and probabilities in appropriate problem situations
Q3 Translate information from and represent information in various forms with equal ease (e.g., tables, charts, graphs, diagrams, geometric figures)
Q4 Use existing algebraic formulas and create new ones in appropriate problem-solving situations
Q5 Estimate and justify probabilities of outcomes of familiar situations based on experimentation and other strategies
Q6 Invent apparatus and mechanical tools needed to perform unique tasks in various situations
Q7 Identify, compare, and contrast different modes of inquiry, habits of mind, and attitudes and dispositions
Q8 Design investigations that are safe and ethical (i.e., obtain consent and inform others of potential outcomes, risks and benefits, and show evidence of concern for human health and safety, concern for non-human species)
Q9 Make and read scale drawings, maps, models, and other representations to aid planning and understanding
Q10 Seek elaboration and justification of data and ideas, and reflect on alternative interpretations of the information
Q11 Use appropriate units for counts and measures
Q12 Create and use databases (electronic and other) to collect, organize, and verify data and observations
Q13 Design and conduct investigations with multiple variables
Q14 Communicate the results of investigations clearly in a variety of situations

Subunit: Scientific Inquiry (continued)
Competencies:

Q15 Examine relationships in nature, offer alternative explanations for the observations, and collect evidence that can be used to help judge among explanations
Q16 Trace the development (e.g., history, controversy, and ramifications) of various theories, focusing on supporting evidence and modification with new evidence
Q17 Select, invent, and use tools, including analog and digital instruments, to make and record direct measurements
Q18 Observe and document events and characteristics of complex systems
Q19 Explain the influence of perspective (e.g., spatial, temporal, and social) on observation and subsequent interpretations
Q20 Create multiple representations of the same data using a variety of symbols, descriptive languages, mathematical concepts, and graphic techniques
Q21 Generate testable hypotheses for observations of complex systems and interactions
Q22 Document potentially hazardous conditions and associated risks in selected homes and public areas
Q23 Participate in public debates, relying on documented and verified data to construct and represent a position on scientific issues
Q24 Construct and test models of physical, biological, social, and geological systems
Q25 Read, verify, debate, and, where necessary, refute research published in popular or technical journals of science (e.g., *Discover*, *Omni*, *Popular Mechanics*)
Q26 Explore discrepant events and develop and test explanations of what was observed
Q27 Conduct theory-based research using surveys, observational instruments, and other methods
Q28 Modify personal opinions, interpretations, explanations, and conclusions based on new information
Q29 Analyze error and develop explanations in various domains
Q30 Formulate taxonomic schemes based upon multivariate models that help to explain similarities and differences in form, distribution, behavior, survival, and origin of objects and organisms
Q31 Demonstrate various logical connections between related concepts (e.g., entropy, conservation of energy)
Q32 Account for discrepancies between theories and observations
Q33 Analyze the changes within a system when inputs, outputs, and interactions are altered

Subunit: Scientific Inquiry (continued)
Competencies:

Q34 Create, standardize, and document procedures

Q35 Determine the sources of significant disparities between the predicted and recorded results and change research procedures to minimize disparities

Q36 Research, locate, and propose applications for abstract patterns (e.g., fractals, Fibonacci sequences, string theory, orbitals)

Q37 Recognize and utilize classification systems for particles, elements, compounds, phenomena, organisms, and others for exploring and predicting properties and behaviors

Q38 Suggest and defend alternative experimental designs and data explanations (e.g., sampling, controls, safeguards)

Q39 Recognize and communicate differences between questions that can be investigated in a scientific way and those that rely on other ways of knowing

Q40 Draw conclusions based on the relationships among data analysis, experimental design, and possible models and theories

Q41 Suggest new questions as a result of reflection on and discussions about their own scientific investigations

Q42 Investigate, assess, and comment on strengths and weakness of the descriptive and predictive powers of science

Q43 Create new information from representations of data in a variety of forms (e.g., symbols, descriptive languages, graphic formats) utilizing a variety of techniques (e.g., interpolations, extrapolations, linear regressions, central tendencies, correlation's)

Subunit: Scientific Knowledge
Competencies:

K1 Investigate various types of dynamic equilibrium (e.g., biological, geological, mechanical, chemical)

K2 Investigate the relationship between the rates of energy exchange and the relative energy level of components with systems (e.g., tropic levels of ecosystems, osmosis, rate of heating and cooling, storms)

K3 Investigate patterns in the natural world (e.g., heredity, crystalline structures, population and resource distributions, diffraction, dispersion, polarization)

K4 Investigate models and theories that help to explain the interactions of components in systems (e.g., conservation of mass, energy, and momentum; food webs; natural selection; entropy; plate tectonics; chaos; relativity; social-psychology)

K5 Investigate degrees of kinship among organisms and groups of organisms

K6 Investigate the limits of the definition of life, and investigate organisms and physical systems that exist at or near these limits (e.g. viruses, quarks, black holes)

K7 Investigate estimates and measurements of a wide range of distances and rates of change

K8 Investigate the historical development of theories of change over time (e.g., natural selection, continental drift, the big bang, geologic change)

K9 Investigate physical and chemical changes in living and non-living systems (e.g., photosynthesis, weathering processes, glaciation, thermal effects of materials, energy cells)

K10 Investigate simulations of nuclear change (e.g., radioactivity, half life, carbon dating)

K11 Investigate conservation principles associated with physical, chemical, and nuclear changes

K12 Formulate descriptions of the impacts of various forms of mechanical and electromagnetic waves on various organisms on each other over time

K13 Formulate models and hypotheses for patterns in the natural world (e.g., earth structures, transportation systems, migrations, communications, constellations)

K14 Formulate explanations for the influences of objects and organisms on each other over time

K15 Formulate and interpret explanations for change phenomena (e.g., mass extinction's, stellar evolution, punctuated equilibrium, molecular synthesis)

Subunit: Scientific Knowledge (continued)
Competencies:

K16 Formulate and interpret explanations for the magnitudes of diversity at different periods of geologic time (e.g., mutation, global cataclysms, continental drift, competition, mass extinction's)

K17 Formulate interpretations of the structure, function, and diversity in a variety of organisms and physical systems (e.g., DNA and RNA variants, nucleons, interaction particles)

K18 Formulate understandings of geologic time (e.g., millennia, periods, epochs)

K19 Formulate an understanding of the historical development of the model of the universe

K20 Formulate explanations and representations of the production, transmission, and conservation of energy in biological and physical systems (e.g., weather, volcanism, earthquakes, electricity, magnetism, cellular respiration)

K21 Formulate models and hypotheses about patterns in the natural world (e.g., social behavior, molecular structure, energy transformation, entropy, randomness, aging, chaos, hormonal cycles)

K22 Formulate interpretations of the relationship between energy exchange and the interfaces between components within systems

K23a Formulate estimations for the range of energies within and between various phenomena (e.g., thermal, electromagnetic, thermonuclear, chemical, electrical)

K23b Formulate explanations for the historical development of descriptions of motions interactions and transformations of matter and energy (e.g., classical Newtonian mechanics, special and general relativity, chaos)

K24 Formulate models that can be used to describe fundamental molecular interactions in living and non-living systems (e.g., cell membranes, semiconductors).

K25 Formulate an understanding of the degree of relationship among organisms and objects based on molecular structure (e.g., proteins, nucleic acids)

K26 Formulate hypotheses and models that may account for observable events (e.g., electricity and magnetism, gravitation, atoms, bonding, chemical reactions, quantum effects, energy flow on biological systems, predator-prey relationships)

K27 Formulate models and hypotheses about change over time (e.g., natural selection, speciation, punctuated equilibrium, phyleytic gradualism, stellar evolution, plate tectonics, radioactive decay, quantum mechanical theory)

Subunit: Scientific Knowledge (continued)
Competencies:

K28 Formulate lists of limitations and propose refinements of standard classification systems (e.g., periodic table, IUPAC, Linnean, standard model)

K29 Formulate specific cases of limitations and possible exceptions of theories and principles regarding the interactions of moving objects and organisms (e.g., fluid flow in vessels, motion near the speed of light, Heisenberg uncertainty principle, meteorological prediction, local variation and diversity, predicting earthquakes, energy transport in cellular respiration)

K30 Formulate plans and contingencies that can be used to accommodate for changes to and stresses on systems (e.g., wildlife and habitat management, corrosion prevention, noise abatement, structure design)

K31 Formulate models of molecular, atomic, ionic, and subatomic structures and the physical and biological implications of these structures (e.g., genes, nucleons, quarks)

K32 Formulate estimates for a wide range of measurements and scales (e.g., angstroms to light years)

K33 Formulate and interpret representations of time from origin to present accounting for phenomena of scale (e.g., smoothness, punctuation's, chaos)

K34 Formulate interpretations of the historical development of various theories of possible causes of diversity among physical and biological phenomena (e.g., the works of Aristotle, Mendel, Darwin, McClintock)

K35 Formulate models and hypotheses that can be used to explain the interactions of components within technological and ecological systems

Subunit: Conditions for Learning Science
Competencies:

C1 Participate actively in dialogue about and resolution of community issues

C2 Assess information from various countries in the original language or translated form to ascertain the perspectives of many cultures

C3 Analyze the scientific ideas presented in science fiction stories and films

C4 Perform and repeat investigations to verify data, determine regularity, and reduce the impact of experimental error

C5 Present the results of investigations in a variety of forums

C6 Contribute to the decisions regarding topics for investigation

C7 Use various creative means to communicate interpretations of scientific ideas, concepts, phenomena, and events

C8 Consider the scientific thinking and language of others

C9 Individually and collaboratively produce clearly written representations of investigative results

C10 Fulfill responsibilities as part of a research group

C11 Select and utilize resources by various criteria (e.g., efficiency, effectiveness, health, safety) that are appropriate to the investigations being conducted by groups

C12 Present persuasive argument based on the scientific aspects of controversial issues

C13 Collect, store, retrieve, and manipulate information with available t technologies alleges that may range from hand processes up through computer applications

C14 Investigate social issues with a scientific perspective (e.g., human rights, wellness, economics, futurism, environmental ethics)

C15 Keep journals of observations and inferences made over an extended period of time and reflecting upon the impact of these recorded ideas on their thinking and actions

C16 Examine the intellect, perspectives, and ethics of notable scientists

C17 Collect and analyze observations made over extended periods of time and compare these to scientific theories

C18 Create presentations of scientific understandings using diverse modes of expressions

C19 Conduct formal scientific debates in the classroom

C20 Wonder about the likelihood of events that may occur by chance or coincidence

C21 Plan and conduct field trips and experiences for small and large groups

C22 Analyze the historical context which leads to and has lead to scientific t theories

Subunit: Conditions for Learning Science (continued)

Competencies:

C23 Seek information on topics of personal scientific interest from a variety of sources
C24 Conduct learner-developed investigations independently and collaboratively over periods of week and months
C25 Listen attentively and critically to presentations of scientific information made by others
C26 Conduct analyses of propaganda related to scientific issues
C27 Perform investigations that require observations over varying periods of time
C28 Experience scientific concepts as interpreted by other cultures through multimedia and local and global specialists
C29 Access appropriate technology to perform complicated, time-consuming tasks
C30 Relate historical accounts of science to the cultural context in which they were written
C31 Work as a contributing member of a collaborative research group
C32 Examine the influences of social and political structures and realities that contribute to inquiry about scientific issues
C33 Use technology (e.g., desktop publishing, teleconferencing, networking) to communicate scientific ideas
C34 Explore and analyze a variety of perspectives on science (e.g., works by men and women of many racial, ethnic, and cultural groups)
C35 Lead groups of learners of various ages in designing, planning, and conducting science activities
C36 Respect the scientific thinking of others and self
C37 Recognize and contrast different epistemologies
C38 Develop possible courses of action in response to scientific issues of local and global concern
C39 Determine the validity of research conclusions in relation to the design, performance, and results
C40 Develop multimedia presentations of group and individual research projects and investigations appropriate for a variety of audiences and forums
C41 Produce interesting and scientifically correct stories and present them using various modes of expression
C42 Reflect on the ideas and content found in their own journal records
C43 Examine ambiguous results and formulate explanations
C44 Recognize and synthesize the contributions to scientific thought of individuals from many cultures

Subunit: Conditions for Learning Science (continued)
Competencies:

C45 Construct models and simulations of the component structures and functions of living and non-living entities
C46 Lead multi-age groups in the examination of and planned resolution for scientific issues
C47 Recognize and choose members of research teams based upon the merit of their ideas and skills
C48 Construct a portfolio of products, documentation, and self-evaluations of his/her own abilities, skills, and experiences
C49 Synthesize scientific information from a variety of sources
C50 Evaluate and prioritize scientific issues based upon risk-benefit analyses
C51 Refining scientific skills from a variety of experiences

Subunit: Applications for Science Learning
Competencies:

A1 Answer student-determined questions by designing databases and drawing inferences from the analyses of the information in these data bases

A2 Make personal behavior decisions by interpreting information that has a scientific basis

A3 Propose courses of action that will validate and demonstrate personal understandings of scientific principles

A4 Guide other learners in their understanding of the interactions of technologies and society at various periods in time

A5 Promote and carry out practices that contribute to a sustainable environment

A6 Study and propose improvements in public services and systems in their community

A7 Choose consumer materials utilizing personal and environmental risk and benefit information

A8 Make inferences and draw conclusions using databases, spreadsheets, and other technologies

A9 Do simple trouble-shooting on common electrical and mechanical systems, identifying and eliminating possible causes of malfunctions

A10 Construct devices that perform simple, repetitive actions

A11 Investigate the functionality of various geometric shapes in the natural world and the designed world (e.g., translations from spherical to plane representations cause distortions, triangular shapes contribute to rigidity and stability in structures, round shapes minimize boundary for a given capacity)

A12 Make decisions regarding personal and public health

A13 Evaluate the social and ecological risks and benefits resulting from the use of various consumer products

A14 Analyze the contributions of advances in technology through history to his/her everyday life

A15 Identify and reduce risks and threats to a sustainable environment

A16 Extend the limits of human capabilities using technological enhancements

A17 Use and recognize various propaganda techniques

A18 Solve unique problems using the results of systematic analyses

A19 Choose everyday consumer products that utilize recent innovation and pass appropriate performance criteria

A20 Refine personal career interests through investigations of the diversity of manufacturing, research, service, and invention processes

Subunit: Applications for Science Learning (continued)
Competencies:

A21 Predict and investigate the working of toys and tools while controlling and manipulating variables (e.g., friction, gravity, forces)

A22 Write, follow, modify, and extend instructions (e.g., equations, algorithms, formulas, flow diagrams, illustrations)

A23 Create products, make inferences, and draw conclusions using databases, spreadsheets, and other technologies

A24 Predict various scenarios and propose solutions to community issues using scientific information (e.g., actuarial tables, census data, topographic maps, incidence data, climatic data)

A25 Use scientific evidence to consider options and formulate positions about the health and safety of others and him/herself

A26 Search for, use, create, and store objects and information using various strategies and methods of organization and access

A27 Research and write environmental impact statements of his/her own design

A28 Compare school-based science perspectives with those gained through cutting-edge technological applications

A29 Design management plans for natural and human-altered environments (e.g., woodlots, patios, lots, lawns, farmlands, forests)

A30 Refine personal career interests

A31 Promote public awareness of the interaction of technology with social i issues

A32 Advocate and propose courses of action for local and global scientific issues using global networks

A33 Use appropriate technologies to prepare and present the findings of investigations incorporating tables, graphs, diagrams, and text

A34 Make informed consumer choices by evaluating and prioritizing information, evidence, and strategies

A35 Develop an informed point-of-view that allows for validation or refutation of the scientific statements and claims of advocated before pursuing courses of action (e.g., contributing support, signing petitions, casting votes)

A36 Differentiate between observations and inferences in the exploration of evidence related to personal, scientific, and community issues

A37 Develop and write environmental impact and safety and hygiene management plans

A38 Use technology to collect, analyze, and communicate information (e.g., electronic networks, desktop publishing, remote sensing, graphing calculators, satellite telemetry, and others)

A39 Design, construct, and market inventions

Unit: Technology Literacy

NOTE: Over 500 Ohio business, industry, and labor representatives examined, altered, and then verified the content for this unit during the TCP Process. The original content was extracted from the Report of the Task Force on Technology Competence—Learner Goals for All Minnesotans, published by the Minnesota State Council on Vocational Technical Education. The Technology Literacy unit forms a critical link between all teachers and stresses the importance of technological impact on teaching and learning. [See "The TCP Process" for more information.]

Competencies:

T1 Demonstrate a systems view of technology based on the interdependence of social, political, economic, and ecological systems

T2 Assess the career, family, and personal development implications of technological change

T3 Demonstrate continuous learning via technology

T4 Demonstrate global appreciation for technology's potential effects on cultures, geographic areas, and the environment

T5 Apply historical perspective on technology to the development and use of new technologies

T6 Apply diverse technologies to store, access, process, create, and communicate information needed to solve problems

T7 Apply legal principles and ethical conduct to the use of technology

T8 Demonstrate competency in mathematics, science, social sciences, communication, and computer skills through the analysis, design, and evaluation of technological systems

T9 Analyze the potential of alternative technological systems to solve problems and/or to extend human capabilities

T10 Use a variety of tools, materials, and equipment in solving problems and extending human capabilities

T11 Assess risks and benefits of technological developments from an ecological, economic, social, and political perspective

T12 Value human diversity as part of a team in suggesting, designing, and testing solutions to technological problems

Unit: Employability Skills

Competency: Develop a career plan

Competency Builders:

Identify current interests and aptitudes
Identify common barriers to employment
Describe strategies to overcome employment barriers
Locate resources for finding employment
Research job trends
Identify career options
Identify advantages and disadvantages of career options (in addition to other than monetary)
Identify job requirements
Investigate education/training opportunities
Evaluate personal strengths and weaknesses

Competency: Prepare for employment

Competency Builders:

Identify traditional and non-traditional employment sources
Identify present and future employment opportunities (by geographic location)
Research job opportunities, including non-traditional careers
Compare salary ranges and benefit packages
Compile occupational profile
Identify rights and responsibilities of equal employment opportunity laws
Design resume and cover letter
Target resume
Secure references
Investigate generic and specific employment tests (e.g., civil service exam; drug screening)
Use follow-up techniques to enhance employment potential
Demonstrate legible written communication skills using correct grammar, spelling, punctuation, and concise wording
Describe methods for handling illegal questions on job application forms and during interviews
Write letter of application
Research prospective employer and services performed
Explain critical importance of personal appearance, hygiene, and demeanor
Interpret job description
Demonstrate appropriate interview question and answer techniques
Demonstrate methods for handling difficult interview questions
Evaluate job offers
Write letter of acceptance
Write letter of declination
Demonstrate good listening skills
Ask for the job tactfully
Participate in extracurricular activities (e.g., student government, community projects,)

Competency: Evaluate the importance of self-esteem as an employability skill

Competency Builders:

Identify factors that affect self-esteem
Compare effects of low self-esteem and high self-esteem
Identify strategies to promote positive self-esteem

Competency: Demonstrate job retention skills

Competency Builders:

Identify employer expectations regarding job performance, work habits, attitudes, personal appearance, and hygiene
Exhibit appropriate work habits and attitude
Demonstrate ability to set priorities
Identify behaviors to establish successful working relationships
Identify alternatives for dealing with harassment, bias, and discrimination based on race, color, national origin, sex, religion, handicap, or age
Identify opportunities for advancement
List reasons for termination
List consequences of being absent frequently from job
List consequences of frequently arriving late for work
Demonstrate interpersonal relations skills (i.e., verbal and written)
Demonstrate negotiation skills
Demonstrate teamwork
Follow chain-of-command
Exhibit appropriate job dedication

Competency: Demonstrate knowledge of work ethic

Competency Builders:

Define work ethic
Identify factors that influence work ethic
Differentiate law and ethics
Describe how personal values are reflected in work ethic
Describe how interactions in the workplace affect personal work ethic
Describe how life changes affect personal work ethic

Competency: Exhibit appropriate work ethic

Competency Builders:

Use time-management techniques
Avoid personal activity during work hours
Attend work as scheduled
Adhere to company and/or governmental policies, procedures, rules, and regulations
Exercise confidentiality
Demonstrate appropriate human relations skills
Adhere to rules of conduct
Accept constructive criticism
Offer constructive criticism
Take pride in work
Resolve conflict
Manage stress
Avoid sexual connotations and harassment
Adjust to changes in the workplace
Demonstrate punctuality
Assume responsibility for personal decisions and actions
Take responsibility for assignments
Follow chain-of-command

Competency: Apply decision-making techniques

Competency Builders:

Identify decision to be made
Identify ownership of decision to be made
Identify possible alternatives and their consequences
Make decisions based on facts, legality, ethics, goals, and/or culture
Apply time factor(s)
Present decision to be implemented
Evaluate decision made
Take responsibility for decision

Competency: Apply problem-solving techniques

Competency Builders:

Identify problem
Select appropriate problem solving tools/techniques
Identify root problem cause(s)
Track root problem cause(s)
Identify possible solutions and their consequences (e.g., long term, short term, crisis)
Use resources to explore possible solutions to problem
Contrast advantages and disadvantages of each solution
Identify appropriate action
Evaluate results
Identify post-preventive action

Competency: Exhibit characteristics for job advancement

Competency Builders:

Display positive attitude
Demonstrate knowledge of position
Perform quality work
Adapt to changing situations and technology
Demonstrate capability/responsibility for different positions
Identify characteristics of effective leaders
Identify opportunities for leadership in work place/community
Demonstrate initiative to affect change in workplace
Participate in continuing education/training program
Responds appropriately to criticism from employer, supervisor, or other employees
Exhibit awareness of corporate culture
Prepare for job setbacks
Exhibit continual growth based on performance evaluation
Set realistic goals

Unit: Professionalism

Competency: Project professional image

Competency Builders:

Define professionalism
Exhibit professional appearance
Exhibit professional manners
Project professional attitude
Identify individuals' vital role in organization
Exhibit proper etiquette in professionally-related situations

Competency: Achieve individual and professional goals

Competency Builders:

Set flexible, realistic, and measurable goals
Identify potential barriers to achieving goals
Identify strategies for addressing barriers to goal achievement
Breakdown long-term goals into short-term goals
Prioritize goals
Commit to goals
Adjust goals
Obtain support for goals
Reward goal achievement

Competency: Manage personal finances

Competency Builders:

Explain need for personal management records
Balance checkbook
Identify tax obligations
Analyze how credit affects financial security
Compare types and methods of investments
Compare types and methods of borrowing
Compare types and methods of insurance
Compare types of retirement options/plans
Identify discriminatory vs. non-discriminatory expenditures

Competency: Support community well-being

Competency Builders:

Identify environmental, educational, and social issues
Participate in social and/or community activities

Competency: Achieve organizational goals

Competency Builders:

Evaluate personal goals in relation to organizational goals
Monitor progress by evaluating feedback
List responsibilities in relation to organization goals
Accomplish assigned tasks
Exercise responsibility in relation to organizational goals
Set appropriate personal performance standards
Communicate goals with supervisor and peers
Demonstrate knowledge of products and services
Promote organizational image and mission

Competency: Demonstrate positive relations in the workplace

Competency Builders:

Identify personality types of self and other
Identify various management styles
Support employer expectations
Support employer decisions
Accept constructive criticism
Give constructive feedback
Adapt to changes in workplace
List factors to consider before resigning
Write letter of resignation

Competency: Manage stressful situations

Competency Builders:

Accept stress as part of daily life
Identify personal and professional factors contributing to stress
Describe physical and emotional responses to stress
Evaluate positive and negative effects of stress on productivity
Identify strategies for reducing stress
Implement strategies to manage stress
Create strategies for developing and maintaining support systems

Competency: Analyze effects of family on work and work on family

Competency Builders:

Identify how family values, goals, and priorities are reflected in work place
Identify responsibilities and rewards associated with paid and non-paid work
Identify responsibilities and rewards associated with families
Explain how family responsibilities can conflict with work
Explain how work can conflict with family responsibilities
Explain how work-related stress can affect families
Explain how family-related stress can affect work
Identify family support systems and resources
Identify work-related support systems and resources
Communicate with family regarding work

Competency: Apply lifelong learning skills

Competency Builders:

Define lifelong learning
Identify factors that cause need for lifelong learning
Analyze effects of change
Identify reasons why goals change
Describe importance of flexibility and adaptability
Evaluate need for continuing education/training

Competency: Manage professional development

Competency Builders:

Identify career opportunities
Modify career plan
Participate in continuing education/training opportunities
Document continuing education/training
Read profession-related manuals, technical journals, and periodicals
Attend meetings, workshops, seminars, conferences, and demonstrations
Participate in professional organizations
Build personal/professional mentor relationship
Build personal/professional support system
Build professional network
Strengthen communication skills
Strengthen leadership skills
Strengthen management skills

Unit: Teamwork

Competency: Demonstrate knowledge of teamwork

Competency Builders:

Define empowerment
Differentiate work groups and teams
Identify conditions essential to teamwork (e.g., brainstorming)
Explain influence of culture (e.g., corporate, community) on teamwork
Identify appropriate situations for using teams
Define team structures (e.g., cross functional, quality improvement, task force, quality circles)
Identify team building concepts
Describe characteristics and dynamics of teams
Identify characteristics of effective team leaders and members
Identify responsibilities of a valuable team member
Identify methods of involving each member of a team
Explain how individuals from various backgrounds contribute to work-related situations (e.g., technical training, cultural heritage)
Explain the purpose of facilitators
Define consensus
Define reward/recognition system

Competency: Demonstrate teamwork

Competency Builders:

Identify purpose of team and intended goal (include time frames)
Structure team around purpose
Define responsibilities of team members
Contribute to efficiency and success of team
Work toward individual and team milestones
Analyze results of team project
Facilitate a team meeting
Assist team member(s) with problem
Monitor time frame
Stress continuous improvement
Accept failure as part of learning

Competency: **Use teamwork to solve problems**

Competency Builders:

Identify appropriate situations for using teams
Use problem-solving process in a team setting
Identify quality management processes/techniques
Identify quality assurance processes/techniques
Prepare presentation

Competency: **Conduct team meetings**

Competency Builders:

Plan agenda
Schedule meeting and location
Invite appropriate personnel
Solicit outside speakers as needed
Assign someone to take minutes
Facilitate introductions
Invite questions and comments and group participation
Focus team on agenda items
Assign appropriate action, time frame and accountability to tasks
Monitor time
Close meeting on time
Publish minutes in timely manner
Set ground rules
Avoid placing individual agendas above the group's agenda

Unit: Quality Assurance

Competency: Demonstrate knowledge of quality assurance

Competency Builders:

Explain the historical evolution of quality assurance (e.g., Deming, ISO 9000)
Explain changes brought about by quality leaders in the world
Explain the ISO 9000 process
Define quality terms
Define quality functions
Identify features of quality planning
Describe control devices used in functional areas (e.g., SPC, equipment)
Explain the relationship among organizational structures, policies, procedures, and quality assurance
Explain importance of internal and external customers
Identify internal and external customers
Describe successful efforts by industry to improve quality and/or reduce costs
Differentiate prevention and detection
Differentiate variable and attribute data
Identify types of coontrol charts
Explain how statistical techniques are tools used to control quality (e.g., SPC, DOE, CR)

Competency: **Demonstrate knowledge of quality cost implications**

Competency Builders:

Identify cost/quality objectives
Classify costs (i.e., direct and indirect, fixed and variable, methods and standards)
Classify quality costs (i.e., prevention, evaluation, pre-delivery failure, post-delivery failure)
Define produce liability
Interpret quality cost reports
Explain consumerism and liability prevention
Define safety terms of product
Identify safety responsibility within organization
Define contracts and torts
Differentiate express and implied warranty
Differentiate warranty and product liability
Explain how warranties are part of contract law
List questions that would need answering in liability claim

Competency: **Demonstrate knowledge of engineering a quality product**

Competency Builders:

Associate customer satisfaction with product characteristics (e.g., usefulness, price, operation, life, reliability, safety, cost of operation)
Define manufacturability
Identify steps in product design (e.g., brainstorming, thumbnail sketches, rendering)
Define reliability factors (e.g., cost, human, producibility)
Identify ways reliability is achieved (e.g., maintainability, good design, design simplification, design redundancy)
Explain the relationship of maintainability to reliability
Define failure
Explain the role of testing and reliability
Define value engineering
Define quality objectives
Identify cost components as they relate to quality objectives
Classify quality costs (i.e. preventive, evaluation, pre-delivery failures, post delivery failures)
Describe predictive maintenance

Competency: Explain importance of interdepartmental relationships to quality assurance

Competency Builders:

Explain need for everyone's commitment in assuring quality
Explain phrase "Everyone is a customer/supplier"
Define quality improvement team models
Explain the importance of top management's support of quality
Explain project selection
Explain project implementation
Explain project evaluation
Explain continuing improvement
Describe future trend of experiment design
Describe future trend of predictive maintenance

Competency: Manipulate quality cost data

Competency Builders:

Develop quality cost data
Translate cost reports
Graph quality cost data (e.g., pareto)

Competency: Manipulate cost control data

Competency Builders:

Develop cost control data
Analyze cost control reports
Provide cost control data
Provide advice on "Make or Buy" decisions (including economical lot size decisions)

Competency: Demonstrate knowledge of basic statistics

Competency Builders:

Describe data collection methods
Collect data
Organize data by flow chart
Interpret data by cause and effect diagrams
Define nominal, ordinal, interval, and ratio data
Define mean, median, and mode
Explain significance of standard deviation
Explain normal distribution

Competency: Demonstrate knowledge of scattergrams

Competency Builders:

Construct scattergram
Interpret for positive, negative, or no correlation between X and Y variables
Test for significance between one and five percent
Explain regression analysis

Competency: Demonstrate knowledge of probability theory

Competency Builders:

Define classical probability
Define empirical probability
Calculate probability for outcomes

Competency: Demonstrate knowledge of precontrol

Competency Builders:

Explain uses of precontrol
Calculate precontrol limits
Explain significance of the limits
Plot values on a precontrol chart
Explain "out-of-control" situation
Make decisions on green, yellow and red conditions

Competency: Demonstrate knowledge of process capability

Competency Builders:

Use X, R, USL, and LSL to determine process capability (upper and lower specification limits)
Calculate estimated process standard deviation
Plot right hand and left hand tail of process variation
Compute Z value for percent of probable defect for process
Calculate C_{PK} values that describe process capability
Describe skewed distributions
List probable causes of skewed distribution

Competency: Use quality control charts

Competency Builders:

Identify operational definitions for attribute criteria
Interpret histogram
Interpret scattergrams
Interpret NP chart
Interpret P chart
Interpret flowchart
Interpret cause-and-effect diagram
Construct P (percentage defective) chart for attributes
Plot control limits of P chart and data points
Check chart for out-of-control conditions
Construct an NP (number defective) chart with control limits and data
Construct C (count of defects) and U (number of defects per unit) charts
Check data on C and U charts
Construct flowchart
Construct cause-and-effect chart

Competency: Interpret $\bar{X}$ and R charts

Competency Builders:

Plot percentages for normal distribution
Test distribution for normality
Explain difference between common cause and special cause
Define an "in-control" process
Explain significance of an out-of-control point on $\bar{X}$ or R chart
Identify patterns and trends on control chart
Identify run up and run down
Test for middle third on control chart
Explain significance of middle third on control chart
Explain Rule of Sevens

Competency: Construct $\bar{X}$ and R charts

Competency Builders:

Arrange data into statistical sub-groups
Explain importance of random sampling
Compute $\bar{X}$ (i.e., average of values) and R (i.e., range of values in subgroup) within sample
Plot in $\bar{X}$ and R on chart
Construct control chart with $\bar{\bar{X}}$ (grand average) and $\bar{R}$ (average range) calculated
Calculate upper and lower control limits for $\bar{X}$-chart
Calculate upper and lower control limits for R-chart

Competency: Conduct process improvement studies

Competency Builders:

Analyze production methods and processes applying statistical process improvement techniques (e.g., SPC, C_{PK})
Identify appropriate statistical techniques for study (e.g., T-tests, F-test, capability, DOEX)
Identify major steps in conducting a study
Define "report" for a study (e.g., goal, objective, study conduct, results, conclusions, discussions)
Integrate results into the total system

Competency: Demonstrate knowledge of JIT

Competency Builders:

Define just-in-time concept (JIT)
Describe various production methodologies (e.g., standard cycle times, routings, standard quantities, multiple-machine tending)
Describe types of inventory control (e.g., Kanban)
Describe importance of flexibility
Differentiate product layout, process layout, fixed position layout, and cellular layout
Differentiate straight-line, U-shaped, S-shaped, convoluted and comb patterns
Describe advantages/disadvantages of layout and patterns
Explain importance of product protection, identification and storage
List methods of identifying products (e.g., labels, bar codes, radio frequency systems and magnetic strip systems)
Describe manual methods of storage and retrieval
Describe automated storage and retrieval systems (ASRS)
Describe automated guided vehicle moving systems (AGVS)

Competency: Apply JIT

Comptency Builders:

Maintain system for physical handling and movement of material in-process and in-storage
Monitor system of physical handling and movement of material in-process and in-storage
Maintain system for physical handling and movement of finished products
Monitor system of physical handling and movement of finished products
Write requests for deviation from specifications
Implement quality control and inspection standards and procedures
Write engineering change notices and rejection reports
Monitor reports of discrepancy or rejects during production process
Conduct quality tests under different environmental conditions

Competency: Demonstrate knowledge of inspection

Competency Builders:

Explain purpose of inspection
Describe scope of inspection
Explain purpose of incoming, ongoing, and final inspections
Explain early detection inspection
Explain how statistical process control (SPC) aids inspection
Define types of nonconformance
Define degrees of nonconformance
Define corrective action
Describe when to 100% inspect
Describe when to sample inspect
Describe methods of testing for material properties (e.g., harness, strength, chemical makeup, flaws, errors in tooling or setup)
Define rework, salvage, and scrap
Describe ethical decisions an inspector may make
Identify purposes of computer-automated inspection
Explain advantages and limitations of automated inspection
Explain disposition of non-conforming material
Explain basic foolproofing concept to build inspection into process (i.e., poka-yoke)
Use checksheets to organize and record inspection results

Competency: Inspect machinery, materials, and products

Competency Builders:

Identify critical material characteristics from specification(s) or drawing(s)
Perform capability studies for machinery and materials acceptance
Identify appropriate acceptance sampling plan
Conduct incoming materials inspection using sampling plan criteria
Identify critical in-process characteristics from specification(s) or drawing(s)
Demonstrate basic metrology skills
Conduct in-process inspection
Identify appropriate inspection reports and follow-up
Gauge R and R (reproducibility and repeatability)
Apply geometric tolerancing
Explain C = O (zero) acceptance plan
Interpret instructions in a control plan

Competency: **Demonstrate knowledge of nondestructive testing**

Competency Builders:

Describe purpose of nondestructive testing
Identify anomalies
Define defects and discontinuities
Identify factors contributing to defects and discontinuities
Describe ultrasonic testing
Describe advantages and limitations of ultrasonic testing
Describe industrial radiography
Compare use of wet and dry particles in magnetic particle inspection
Explain advantages and limitations of penetrant inspection
Describe microwave testing
Describe holographic inspection
Explain choice of most suitable nondestructive test method
Describe eddy-current testing

Unit: Technical Recording and Reporting

Competency: Demonstrate proficiency in technical recording

Competency Builders:

Describe various documentation procedures
Interpret specifications or drawings
Observe process
Ask open-ended questions
Record process (e.g., flowchart, step-by-step)
Identify parameters
Record accurate, truthful data
Maintain test logs
Compile cumulative reference notebook/record
Measure appropriate parameters
Draft preventive maintenance and calibration procedures

Competency: Demonstrate proficiency in technical reporting

Competency Builders:

Use data books and cross reference/technical manuals
Compose technical memoranda
Identify type of report or format needed
Use appropriate format
Compile relevant data
Design charts and graphs
Analyze data
Draw conclusions
Explain analytical methods used
Outline reports
Write reports
Present reports

Unit: Computer Literacy

Competency: Describe personal computer operations

Competency Builders:

Explain how data is stored in main computer memory
Explain how computer system executes program instruction
Explain computer storage capacity
Explain how data is represented
Describe data storage techniques
Identify types of memory

Competency: Explain information processing cycle

Competency Builders:

Define operating systems (e.g., DOS, OS/2, UNIX, MAC)
Describe computer languages and their use
Describe computer languages and their use
Describe computer languages and their use
Describe difference between data files and program files
Explain PC layout
Explain PC network layout
Explain mini/mainframe network layout
Differentiate hardware and software
Differentiate open from proprietary architecture

Competency: Operate computer hardware

Competency Builders:

Practice proper media handling techniques (e.g., magnetic fields, dust, liquids)
Identify hardware and its use
Use hardware (e.g., mouse, diskettes, drive, modems, touch screen, printers, digitizers, scanners, cables, protection devices)
Keyboard efficiently
Demonstrate basic care of hardware
Explain need for and application of security levels/procedures
Perform basic hardware troubleshooting
Explain hardware addressing techniques

Competency: Use software

Competency Builders:

Define software types and functions
Describe basic disk operations and care
Perform functions necessary to operate software
List advantages and disadvantages of integrated and dedicated software
Operate system software
Operate diagnostic software
Demonstrate basic proficiency in spreadsheet use
Demonstrate basic proficiency in word processing
Demonstrate basic proficiency in database use
Demonstrate basic proficiency in network use
Demonstrate basic proficiency of utility (e.g., WINDOWS, GUI)
Demonstrate basic proficiency in report writing
Demonstrate system commands
Differentiate ethical use/misuse of software
Describe bulletin boards/electronic mail
Apply security levels/procedures while handling sensitive data
Explain data compression techniques
Explain use and deletion of passwords

Unit: Workplace Safety

Competency: Apply general safety precautions

Competency Builders:

Identify local, state, and federal rules and regulations
Identify personal protective wear and equipment
Identify visual controls (e.g., monitors, read outs)
Identify auditory controls
Identify common sense housekeeping
Interpret hazardous materials notices on containers
Use personal protective wear and equipment
Apply workplace safety rules and procedures
Apply personal safety rules and procedures
Apply workplace organization (e.g., housekeeping)
Apply applicable electrical, mechanical, steam, hydraulic and (e.g., pneumatic safety rules and procedures)
Apply fire safety rules and procedures
Apply hazardous wastes rules and procedures
Apply first aid
Locate (MSDS)
Perform lockout and tagout
Recycle scrap metal, chips, shavings, coolants, solvents, trash, and waste materials
Apply common sense housekeeping
Use preventive maintenance checklists

Competency: **Demonstrate knowledge of safety and workplace hazards**

Competency Builders:

Describe corrective procedures for unsafe conditions
Identify types and potential level of workplace hazards (e.g., physical hazards, fire, chemicals, noise, ionizing radiation, ultraviolet, temperature extremes, ergonomics, biological hazards)
Identify safety materials/equipment (e.g., absorbant socks, oil dry)
Interpret Material Safety Data Sheets (MSDS)
Explain purpose(s) of OSHA and NIOSH
Explain purpose(s) of NEC and NFPA
Identify purpose of emergency evacuation routes, master switch and lockout locations, and safety color coding systems
Identify roles of industrial hygienists, safety professionals, occupational physicians, and occupational nurses
Describe methods of evaluating potential hazards (e.g., visual analysis)
Describe methods of correcting potential hazards
Describe various types of toxicity (e.g., chronic, immediate)
Identify need for reporting accidents
Explain precautions required when using toxic or flammable materials
Define confined space and related requirements
Explain how international directives relate to safety

Competency: **Explain purpose of industrial pollution control systems**

Competency Builders:

Describe types of air, water, solid waste, and noise pollution
Explain purpose of air pollution control systems
Explain purpose of water pollution control systems
Explain purpose of solid waste pollution control systems
Explain purpose of noise pollution control systems
Explain basic philosophy of "right to know" legislation
Explain purpose(s) of EPA
Identify "costs" of industrial pollution control (i.e., dollars vs. impact to environment)
Describe ethics of environmental issues

Competency: Demonstrate knowledge of ergonomics

Competency Builders:

Define ergonomics
Define risk factor
Define maximum permissible limit (MPL) and action limit (AL) for lifting
Define cumulative trauma disorder (CTD)
Identify susceptibility factors for CTD
Minimize extreme joint movement
Minimize use of excessive muscle force
Minimize repetitive tasks
Minimize mechanical stresses (e.g., sharp edges, heat, cold, hard surfaces, weights, vibration)
Minimize awkward body positions
Explain use of rest pauses
Explain need for mats and footrest for standing jobs
Explain need for appropriate working heights of chairs, stools, workbenches, equipment
Explain need for adequate lighting
Explain use of anthropometric (i.e., centering one's view of everything around man) design

Unit: Supervision

Competency: Perform supervisory functions

Competency Builders:

Define supervision
Conduct task analysis
Create organizational and/or departmental charts
Apply company policies and procedures
Maintain workplace procedures manuals
Prepare budgets
Monitor budgets
Prepare managerial reports
Analyze daily production reports
Maintain appropriate work environment
Conduct tours
Facilitate assignments
Assign work
Delegate job tasks
Monitor progress
Prepare productivity reports
Provide training for new policies
Troubleshoot workplace problems
Coordinate workplace activities
Appraise performance
Document personnel issues
Coordinate administrative duties

Competency: Coordinate training

Competency Builders:

Assess training needs
Secure training resources, materials and equipment
Train employees
Evaluate progress of trainee
Provide feedback
Solicit feedback
Receive feedback
Assess feedback

Unit: Basic Electronics

Competency: Demonstrate proficiency in electronics fundamentals

Competency Builders:

Identify electronic components and schematic symbols
Describe basic atomic structure and its relationship to electricity
Describe the relationship between electrical and magnetic properties
Describe the electrical and magnetic properties of a magnet
Describe the photoelectric effect
Describe the thermocouple effect
Describe the electrical effect of friction
Use metric units to solve electronic unit problems
Identify sources of electricity
Describe principles and operations of electrochemical supplies
Describe voltage, current, resistance, power, and energy
Apply Ohm's Law
Apply Kirchoff's Laws
Apply power formulas
Explain Thevenin's Theorem
Explain Norton's Theorem
Interpret color codes and symbols to identify electrical components and values
Measure properties of circuits using test equipment
Describe electrostatic discharge (ESD) procedures

Competency: Demonstrate proficiency in DC circuits

Competency Builders:

Compute conductance of conductors and insulators
Measure resistance and current of conductors and insulators
Measure properties of a circuit using volt-ohm meter (VOM) and digital volt-ohm meter (DVM)
Build series, parallel, and combination circuits
Build bridge circuits
Build voltage divider circuits (loaded and unloaded)
Compute voltage divider circuits (loaded and unloaded)
Demonstrate maximum power transfer theory
Describe magnetic properties of circuits and devices
Explain physical and electrical characteristics of capacitors and inductors
Describe RC and RL time constants
Compute RC and RL time constants
Demonstrate use of diodes in DC circuits
Identify need for rectification
Operate power supplies for DC circuits
Analyze frequency spectrums
Construct the operation of DC circuits that demonstrate maximum power transfer theory
Use meters and oscilloscopes
Measure current, voltage, and resistance in DC circuits
Explain simple DC generator action
Explain simple DC motor action
Explain principals of solid-state switching devices
Solve algebraic problems to include exponential (prerequisite to DC) (algebraic calculation)
Explain use of DC in relation to communications
Identify classes, voltage ratings and/or polarity of electronic components
Identify use of circuit protective devices (e.g., fuses, breakers)
Troubleshoot DC circuits

Competency: Demonstrate proficiency in AC circuits

Competency Builders:

Analyze properties of an AC signal
Describe principles and operation of characteristics of sinusoidal and non-sinusoidal wave forms
Identify AC sources
Describe principles and operation of characteristics of capacitive circuits
Operate capacitive circuits
Describe principles and operation of characteristics of inductive circuits
Operate inductive circuits
Describe principles and operation of transformers
Demonstrate operation of AC circuits utilizing transformers
Use maximum power transfer theorems
Use Thevenin's and Norton's theorem to analyze AC circuits
Measure power in AC circuits
Operate capacitor and inductor analyzers for AC circuits
Operate differentiators and integrators to determine RC and RL time constants
Describe principles and operation of characteristics of series and parallel resonant circuits
Build series and parallel resonant circuits
Identify classes, voltage, ratings and/or polarity of electronic components
Identify use of circuit protective devices (e.g., fuses, breakers)
Describe principles and operation of characteristics of frequency selective filter circuits
Calculate logarithmic to obtain gain (dB) using tables or calculator/computer
Operate frequency selective filter circuits
Operate polyphase circuits
Describe basic motor theory and operation
Describe basic generator theory and operation
Operate power supplies for AC circuits
Describe principles and operation of various power conditioning (e.g., isolation transformers, surge suppressors, uninterruptable power systems)
Describe principles and operation of various safety grounding systems (e.g., lightning arresters, ground electrostatic discharge, fault interrupters, etc.)
Describe characteristics of inductors in series and parallel circuits
Describe characteristics of capacitance in series and parallel circuits
Compare resistive-capacitive (RC) and resistive-inductive (RL) time constants (TC)
Measure voltage, current, time, frequency (f), and phase relationships of AC sine wave signal
Describe frequency (F) and phase relationships

Competency: **Demonstrate proficiency in AC circuits (CONTINUED)**

Competency Builders:

Describe resonance of inductive-capacitive (LC) circuits
Calculate impedance match and maximum transfer of power
Measure current, voltage, and resistance in AC circuits
Identify 50/60 Hertz
Explain simple AC generator action
Explain simple AC motor action
Calculate power factor in AC circuits
Explain harmonics and its effects on power quality
Solve basic trigonometric problems as applicable to electronics
Calculate peak (PK), root mean square (RMS), and average values
Troubleshoot AC circuits

Unit: Fundamentals of Electronics Technology

Competency: **Demonstrate proficiency in discrete solid-state devices**

Competency Builders:

Describe properties of semiconductor materials
Describe operating characteristics and applications of PN junctions
Demonstrate operation of diode circuits
Troubleshoot diode circuits
Repair diode circuits
Describe operating characteristics and applications of bipolar transistors
Describe operating characteristics and applications of field effect transistors (e.g., FET + s/MOSFET + s)
Describe operating characteristics and application of special diodes/transistors
Describe operating characteristics and applications of opto-electronic devices (e.g., gate isolators, interrupt sensors, infrared sensors)
Describe operating characteristics and applications of single-stage amplifiers
Demonstrate the operation of the single-stage amplifiers
Troubleshoot single-stage amplifiers
Repair single-stage amplifiers
Demonstrate the operation of thyristor circuitry (SCR, TRIAC, DIAC, etc.)
Troubleshoot thyristor circuitry (SCR, TRIAC, DIAC, etc.)
Operate analog and digital equipment for solid-state devices
Operate power supplies for solid-state devices
Operate oscilloscopes for solid-state devices
Operate function generators for solid-state devices
Operate curve tracers
Operate transistor testers

Competency: Demonstrate proficiency in analog circuits

Competency Builders:

Operate measuring instruments for analog circuits
Describe operating characteristics and applications of linear integrated circuits
Describe operating characteristics and applications of power supplies and filters
Describe operating characteristics and applications of operational amplifier circuits
Demonstrate the operation of operational amplifier circuits
Describe the operating characteristics and applications of regulated and switching power supply circuits
Demonstrate the operation of regulated power supply circuits
Describe operating characteristics and applications of active filters
Demonstrate the operation of active filter circuits
Describe operating characteristics and applications of sinusoidal and non-sinusoidal oscillator circuits
Demonstrate the operation of oscillator circuits
Describe the operating characteristics and applications of motor phase-shift control circuits (single-phase and multi-phase)
Describe the operating characteristics and applications of cathode ray tubes

Competency: Demonstrate proficiency in digital circuits

Competency Builders:

Operate logic problems for digital circuits
Operate power supplies for digital circuits
Operate pulsers for digital circuits
Operate oscilloscopes for digital circuits
Describe characteristics of integrated circuit (IC) logic families
Describe the principles and operation of types of logic gates and their truth tables
Demonstrate the use of logic gates
Describe the principles and operation of combinational logic circuits
Demonstrate the operation of combinational logic circuits
Describe the principles and operation of numbering systems, codes, and arithmetic operations
Minimize logic circuits using Boolean operations
Describe the principles and operation of types of flip-flops
Demonstrate the operation of flip-flops
Describe the principles and operation of types of registers and counters
Demonstrate the operation of registers and counters
Describe the principles and operation of clock and timing circuits
Demonstrate the operation of clock and timing circuits
Describe the principles and operation of types of arithmetic-logic circuits
Demonstrate the operation of arithmetic-logic circuits
Describe the principles and operation of types of encoders and decoders
Demonstrate the operation of encoders and decoders
Describe the principles and operation of types of multiplexer and demultiplexer circuits
Demonstrate the operation of multiplexer and demultiplexer circuits
Describe the principles and operation of digital-to-analog and analog-to-digital circuits
Demonstrate the operation of digital-to-analog and analog-to-digital circuits
Describe the principles and operation of types of digital display circuits
Demonstrate the operation of digital display circuits
Describe the types of digital display devices
Demonstrate the operation of digital display devices
Describe the operating characteristics and applications of fiber optics
Demonstrate the operation of fiber optics

Competency: **Demonstrate basic proficiency in microprocessors**

Competency Builders:

Describe the essential components of a microprocessor and their functions
Identify the levels of computer languages
Operate oscilloscopes and logic/data analyzers
Describe the principles and operation of BUS concepts
Describe the principles and operation of types of memory circuits
Demonstrate the operation of memory circuits
Troubleshoot memory circuits
Repair memory circuits
Describe microprocessor instruction sets
Describe the principles and operation of microprocessor machine code
Demonstrate the use of microprocessor machine code
Debug microprocessor machine code
Interface various types of peripherals
Describe the use of microprocessor simulator(s)

Competency: **Describe manufacturing of electronic devices and micromechanisms**

Competency Builders:

List properties of electronic packaging materials
Describe manufacturing of electronic products chips; integrated circuits; printed integrated circuits
Describe joining and assembly of electronic components
Describe coating and etching processes
List principles of packaging electronic components
Describe manufacture of miniature devices
Describe testing of joints
Describe reliability of electronic product testing
Describe the advantages and disadvantages of various advanced packaging techniques (e.g., SMD, MCM)
Describe methods of fabrication

Unit: Troubleshooting and Repair

Competency: Demonstrate troubleshooting skills

Competency Builders:

Explain role of preventive maintenance
Differentiate normal and abnormal operations
Explain troubleshooting procedures
Explain logical actions taken to troubleshoot
Use proper troubleshooting aids
Demonstrate knowledge of safety rules for troubleshooting and repair procedures
Maintain troubleshooting and repair records
Interpret prints (e.g., PID, loopsheets)
Use manufacturer's manuals, schematics, and troubleshooting charts
Isolate faults, shorts, and open circuits

Competency: Apply troubleshooting techniques to DC circuits

Competency Builders:

Identify noise problems
Isolate faults in series, parallel and series parallel
Isolate faults in bridge circuits
Isolate faults in DC power supplies
Perform polarity check
Isolate faults to DC drive system
Isolate faults in voltage divider circuits
Repair faults

Competency: Apply troubleshooting techniques to AC circuits

Competency Builders:

Isolate faults in capacitive circuits
Isolate faults in inductive circuits
Isolate faults in AC circuits utilizing transformers (e.g., step up and step down)
Isolate faults in differentiator and integrator circuits
Isolate faults in RC, RL, and RLC circuits
Isolate faults in frequency selective filter circuits
Isolate faults to AC frequency drive systems
Repair faults

Competency: Apply troubleshooting techniques in discrete solid-state devices

Competency Builders:

Isolate faults in diode circuits
Isolate faults in thyristor circuitry (e.g., SCR, TRIAC, DIAC)
Isolate faults in transistor circuits
Isolate faults in operational amplifier circuits
Isolate faults in single-stage amplifiers
Isolate faults in open circuits
Repair faults

Competency: Apply troubleshooting techniques to analog circuits

Competency Builders:

Isolate faults in single and multistage amplifiers
Isolate faults in audio power amplifiers
Isolate faults in regulated and switching power supply circuits
Isolate faults in active filter circuits
Isolate faults in oscillator circuits
Isolate faults in operational amplifier circuits
Isolate faults in power supplies (loaded and unloaded) and filters
Repair faults

Competency: Apply troubleshooting techniques to digital circuits

Competency Builders:

Identify noise problems
Isolate faults in multiplexer and demultiplexer circuits
Isolate faults in digital display circuits
Isolate faults in logic gates
Isolate faults in flip-flops
Isolate faults in registers and counters
Isolate faults in clock and timing circuits
Isolate faults in arithmetic-log circuits
Isolate faults in encoders and decoders
Isolate faults in digital-display devices
Repair faults

Competency: Apply troubleshooting techniques to a microcomputer system

Competency Builders:

Isolate faults to systems boards
Isolate faults to memory circuits
Isolate faults to data storage devices
Isolate faults in power supplies
Troubleshoot I/O ports
Isolate faults in I/O interface circuitry
Use diagnostic software
Repair faults

Competency: **Apply troubleshooting techniques to manufacturing systems**

Competency Builders:

Identify individual process blocks of assembly line or process
Identify process block interfaces
Demonstrate steps required for efficient systems troubleshooting
Isolate system faults to process block
Isolate block faults using schematics
Isolate block faults using programmable controller indicators
Isolate block faults using volt meter
Repair block faults by replacing fault component or wiring

Unit: Industrial Electricity

Competency: Explain basic industrial electricity theory

Competency Builders:

Describe atomic structure and its relationship to electricity
Describe the relationship between electrical and magnetic properties
Describe the electrical and magnetic properties of a magnet
Describe the photoelectric effect
Describe the thermocouple effect
Describe the electrical effect of friction
Identify sources of electricity
Identify potential sources of electricity
Describe differences between AC/DC
Describe effects varying degrees of electricity have on the human body

Competency: Use the National Electrical Code (NEC)

Competency Builders:

Use NEC to identify correct materials
Use NEC to identify correct methods
Use NEC to identify correct applications
Use NEC to identify correct safety procedures

Competency: Explain operation of electrical distribution systems

Competency Builders:

Follow NFPA, local, state, and national codes
Describe functions of permits and licensing requirements
Explain generation of electricity
Explain transmission of electricity
Explain end user distribution

Competency: Maintain basic electrical systems

Competency Builders:

Replace electrical cords
Replace batteries
Replace fuse(s)
Replace switches and other sensors
Replace plugs and sockets
Replace control panel components (e.g., relays, motor starters)
Replace AC motors (e.g., 3 phase, single phase)
Replace DC motors

Competency: Interpret electrical/electronic drawings

Competency Builders:

Interpret basic electric/electronic standards and symbols (e.g., NEC, IEC)
Interpret schematic drawings
Interpret cable drawings
Interpret component drawings
Interpret logic diagrams
Interpret control panel drawings
Interpret connection drawings
Interpret interconnection drawings
Interpret printed circuit board drawings
Interpret harness drawings
Interpret package drawings
Interpret mechanical/electronic production blueprints and assembly drawings

Competency: **Demonstrate proficiency in direct current (DC) circuits**

Competency Builders:

Describe voltage, current, resistance, power, and energy
Solve algebraic problems to include exponential (prerequisite to DC)
Measure properties of a circuit using volt-ohm meter (VOM) and digital volt-ohm meter (DVM) meters and oscilloscopes
Apply Ohm's Law
Construct parallel circuits
Construct series circuits
Construct series parallel and bridge circuits
Define voltage divider circuits (loaded and unloaded)
Construct DC circuits that demonstrate the maximum power transfer theory
Solve problems in electrical units utilizing metric units
Describe the principles and operation of electrochemical supplies
Apply Kirchoff's law
Interpret color codes and symbols to identify electrical components and values
Measure properties of a circuit using analog and digital meters and oscilloscopes
Measure conductance and resistance of conductors and insulators
Describe magnetic properties of circuits and devices
Describe the physical and electrical characteristics of capacitors and inductors
Describe RC and RL time constants
Set up power supplies for DC circuits
Operate power supplies for DC circuits
Analyze frequency spectrums
Apply Thevenin's and Norton's theorems

Competency: **Demonstrate proficiency in alternating current (AC) circuits**

Competency Builders:

Solve basic trigonometric problems as applicable to electricity (prerequisite to AC)
Analyze AC signals utilizing VOM, DVM, oscilloscope, frequency counter and function generator
Analyze power in AC circuits
Measure power in AC circuits
Operate capacitor and inductor analyzers for AC circuits
Analyze properties of an AC signal
Describe the principles and operation of the characteristics of sinusoidal and non-sinusoidal wave forms
Identify AC sources
Describe the principles and operation of the characteristics of capacitive circuits
Demonstrate the operation of capacitive circuits
Describe the principles and operation of the characteristics of inductive circuits
Demonstrate the operation of inductive circuits
Describe the principles and operation of the principles of transformers
Demonstrate the operation of AC circuits utilizing transformers
Operate differentiators and integrators to determine RC and RL time constants
Describe the principles and operation of the characteristics of RLC circuits (series, parallel, and complex)
Demonstrate the operation of RLC circuits (series, parallel, and complex)
Describe the principles and operation of the characteristics of series and parallel resonant circuits
Operate series and parallel resonant circuits
Describe the principles and operation of the characteristics of frequency selective filter circuits
Demonstrate the operation of frequency selective filter circuits
Operate polyphase circuits
Describe basic motor theory and operation
Describe basic generator theory and operation
Operate power supplies for AC circuits
Describe the principles and operation of various power conditioning (e.g., isolation transformers, surge suppressors, uninterruptable power systems)
Describe the principles and operation of various safety grounding systems (e.g., lightning arresters, ground fault interrupters, etc.)
Apply maximum power transfer theorems
Apply Thevenin's and Norton's theorems to analyze AC networks

Unit: Electrical Test and Measurement Equipment

Competency: **Demonstrate proficient use of electrical test equipment**

Competency Builders:

Describe function and operation of logic probe and logic analyzer
Describe function and operation of power monitor
Describe function and operation of signal generator
Describe function and operation of spectrum analyzer
Describe function and operation of AC/DC hi-pot
Describe function and operation of time-domain reflectometer (TDR)
Describe function and operation of megger
Describe function and operation of curve tracer/analogger
Apply test equipment to DC circuits
Apply test equipment to AC circuits
Apply test equipment to solid-state devices
Apply test equipment to digital circuits
Apply test equipment to analog circuits
Apply test equipment to microprocessors

Competency: **Demonstrate proficient use of electrical measurement equipment**

Competency Builders:

Describe function and operation of analog volt-ohm-meter (AVOM)
Describe function and operation of digital volt-ohm-meter (DVOM)
Describe function and operation of amp probe
Describe function and operation of oscilloscopes
Describe function and operation of operation of infrared heat sensor
Apply measurement equipment to DC circuits
Apply measurement equipment to AC circuits
Apply measurement equipment to solid-state devices
Apply measurement equipment to digital circuits
Apply measurement equipment to analog circuits
Apply measurement equipment to microprocessors

Unit: Drafting Technology

Competency: Apply basic drafting skills

Competency Builders:

Use drafting equipment, measuring scales, drawing media, drafting instruments and consumable materials, blueprint machine
Identify line styles, weights (alphabet of lines)
Select proper drawing scale, introduction to different types
Prepare title blocks and other drafting formats
Apply freehand and other lettering techniques
Prepare multi-view drawings
Prepare multi-view sketches
Prepare orthographic views
Prepare change control block
Describe change control block/revision block
Measure angles
Draw horizontal, vertical, angular, parallel, and perpendicular lines
Transfer an angle
Construct tangent lines (to arcs) and tangent arcs (to arcs)
Bisect angles and arcs
Bisect lines
Divide lines
Construct three-point circle
Construct regular hexagon, pentagon, and octagon
Reproduce a drawing
Prepare single-view drawings
Prepare dimension drawings
Interpret notes and dimensions to determine part
Draw arcs, circles, and conics
Transfer measurements

Competency: Apply intermediate drafting skills

Competency Builders:

Describe types of blueprints and their applications
Apply isometric, oblique and perspective sketching techniques
Prepare isometric, oblique and perspective sketches
Prepare sectional views
Prepare auxiliary views
Identify ANSI symbols
Prepare views of drilled and tapped holes, counterbores, countersinks
Apply systems drafting techniques
Identify a bill of materials
Dimension drawings using ANSIy14.5 standards
Describe purpose of auxiliary and sectional views

Competency: Apply advanced drafting skills

Competency Builders:

Interpret reports and specifications
Prepare pictorial drawings
Prepare schematics
Draw conics
Interpret basic pneumatic/hydraulic standard and symbols
Interpret various drawings (e.g., welding, casting, stamping, forging, civil, maps, pattern shop)

Competency: Interpret basic prints

Competency Builders:

Visualize object from drawing
Interpret orthographic projections
Interpret isometric views
Interpret sectional views
Interpret detail and assembly drawings
Interpret dimensions
Interpret tolerances

Competency: Interpret intermediate prints

Competency Builders:

Interpret screw thread specifications
Identify structural steel shapes
Interpret special symbols
Interpret electrical, pneumatic/hydraulic drawings
Interpret schematics

Competency: Interpret advanced prints

Competency Builders:

Interpret GD&T characteristic symbols
Interpret GD&T supplementary symbols

Competency: **Demonstrate knowledge of basic geometric dimensioning and tolerancing**

Competency Builders:

Identify geometric characteristics and symbols (i.e., flatness, straightness, roundness, cylindricity, profile of line, profile of surface, perpendicularly, angularity, parallelism, circular, runout, total indicated runout, position, concentricity, and symmetry)
Define maximum material condition
Define least material condition
Define regardless of feature size condition
Describe feature control blocks
Describe datum surfaces and targets
Define flatness (pitch)
Define straightness (yaw)
Define roundness
Define cylindrically
Define profile of line
Define profile of surface
Define perpendicularity
Define angularity
Define parallelism
Define circular runout
Define total runout
Define true position concept to determine tolerance for location of holes in mating parts

Competency: **Convert dimensions and tolerances**

Competency Builders:

Convert dimensions and tolerances from English units to metric units
Convert dimensions and tolerances from metric units to English units

Competency: Apply revision control process

Competency Builders:

Apply drawing balloons
Apply documentation (including project filing, back-up material, tracking process)
Apply change control block
Apply revision levels

Competency: Demonstrate dimensioning techniques

Competency Builders:

Construct arrowheads using various styles/disciplines
Apply symbols for surface and texture control
Add labels/notes to drawing
Interpret decimal tolerance dimensions
Dimension arcs
Dimension angles
Dimension curves
Dimension rounded-end shapes
Dimension spherical objects
Dimension cylindrical objects
Dimension cones, pyramids, and prisms
Dimension features on circular center line
Dimension theoretical point of intersection
Dimension object using rectangular coordinate system
Dimension object using polar coordinate system
Dimension object using tabular coordinate system
Dimension object using ordinate dimensioning system

Competency: Apply geometric dimensioning and tolerancing

Competency Builders:

Interpret decimal tolerance dimensions
Calculate clearance fit tolerances of mating parts
Dimension clearance fit tolerances of mating parts
Calculate interference fit tolerances of mating parts
Dimension interference fit tolerances of mating parts
Calculate tolerances to mating parts using standard fit tables
Assign tolerances to mating parts using standard fit tables
Apply positional and form tolerancing symbols
Apply symbols for true position
Apply symbols for maximum material control and regardless of feature size
Calculate effects of dimensional stack-up
Calculate transitional fit tolerances
Dimension transitional fit tolerances

Competency: Perform basic physical layouts

Competency Builders:

Use inside diameter (ID), outside diameter (OD), and hermaphrodite calipers
Layout with combination square
Layout with scriber, divider and trammel
Use surface plate
Use surface gage
Use layout fluid
Use V-blocks
Use clamps
Use angle plate
Use parallels
Use punches
Use transfer method tools
Use layout hammer
Use machinist's square
Use universal bevel protractor
Use machinist's scale

Competency: Prepare mechanical drawings

Competency Builders:

Interpret basic mechanical standards and symbols
Prepare assembly drawings
Prepare welding drawings
Prepare bearing drawings
Prepare casting drawings
Prepare forging drawings
Prepare tool drawings
Prepare molding diagrams
Prepare drawings with special processed holes
Prepare stamping drawings
Prepare numerical control drawings/instructions
Prepare installation drawings
Prepare purchase part drawings
Prepare approval drawings

Competency: Prepare advanced mechanical drawings

Competency Builders:

Resolve problems by descriptive geometry and revolutions
Use precision dimensioning to include geometric characters
Use precision measuring instruments (e.g., calipers)
Prepare fastener drawings
Prepare cam drawings
Prepare gear drawings
Prepare spring drawings
Prepare pulley and chain drive drawings

Unit: CADD Fundamentals

Competency: Demonstrate basic use of computer operating system

Competency Builders:

Create ASCII text files with a text editor
Explain rules for naming files and directories
Manage files
Create directories
Remove directories
Change directories
Copy files
Rename files
Erase files
Format diskettes
Label diskettes
Explain the syntax of operating system commands
Use wildcards in operating system commands

Competency: Operate a CADD system

Competency Builders:

Execute CADD system
Use keyboard input
Use screen and tablet menus
Use other input devices (e.g., scanner, digitizer)
Create scaled plots
Operate a pen plotter
Operate a printer-plotter (i.e., laser plotter)
Access on-line help for commands
Use file conversion
Use data transfer

Competency: Select entities for action

Competency Builders:

Add or remove entities separately
Add or remove entities using a window
Add or remove entities with a crossing-box
Select entities using a fence
Select entities by other methods (e.g., last, previous, type, all, etc.)

Competency: Create 2-D orthographic drawings

Competency Builders:

Create primitive drawing entities
Draw utilizing absolute Cartesian coordinates
Draw utilizing relative Cartesian coordinates
Draw utilizing polar coordinates
Draw using construction aides (e.g., snaps, grid, snap, etc.)
Change drawing attributes
Edit drawing entity properties (e.g., color, layer, thickness, linetype)
Construct drawing entities (e.g., offset, timer, extend, break, mirror, etc.)
Edit drawing entities (e.g., offset, trim, extend, break, mirror, etc.)
Set system variables (e.g., units, scale)
Use system variables
Create layers
Name layers
Manipulate layers
Save files
Create back-ups
Create hatches, patterns, symbols
Recall drawing templates/blocks

Competency: Annotate orthographic drawings

Competency Builders:

Create text styles
Edit text styles
Select text styles
Apply notes

Competency: Dimension orthographic drawings

Competency Builders:

Create dimensions
Edit text
Control dimension variables/models

Competency: Control display

Competency Builders:

Apply view control while drawing (e.g., zoom and pan)
Control view resolution (e.g., viewers)
Save views
Display views

Competency: Extract entity and drawing information

Competency Builders:

Measure distances
Measure areas
Identify locations
List entity characteristics (e.g., length, size, location, properties, etc.)

Unit: Equipment Installation

Competency: Explain installation procedures

Competency Builders:

Explain relocation procedures for new equipment in an existing facility
Explain the use of anchors and isolators
Explain procedures for moving and installing new equipment
Explain leveling and aligning procedures
Explain test run guidelines
Explain safety precautions for equipment installation procedures
Explain grounding procedures
Explain installation of utilities (e.g., electricity, air, water, drains)

Competency: Prepare for equipment installation

Competency Builders:

Identify equipment requirements (including safety)
Identify maintenance services needed
Identify method of moving and equipment needed
Identify measuring devices
Calculate weights
Follow manufacturer's specifications and mannuals
Identify applicable electrical, mechanical, hydraulic, and/or pneumatic principles
Read drawings/schematics
Revise drawings if applicable
Interpret prints

Competency: Install Equipment

Competency Builders:

Prepare site
Use measuring devices
Calculate weight
Follow manufacturer's specifications
Use appropriate moving equipment
Align equipment to layout specifications
Apply electrical, mechanical, hydraulic, and/or pneumatic principles

Competency: Explain rigging functions

Competency Builders:

Estimate the weight of a load
Find the center of gravity
Identify the rigging and slings used in maintenance work
Explain safety inspection procedures for rigging, ropes, and slings
Perform safety inspection procedures for rigging, ropes, and slings
Identify rope fiber types
Tie rigging knots, bends, and hitches
Identify types of wire rope
Cut wire rope assemblies and termination's
Identify cranes and hoists
Identify and explain scaffolding types
Identify safety equipment (e.g., life belts, nets, etc.)

Competency: Perform rigging functions

Competency Builders:

Perform safety inspection procedures for rigging, ropes, and slings
Tie rigging knots, bends, and hitches
Cut wire rope
Seize wire rope
Install wire rope eyes, sockets, and hooks
Splice wire rope
Erect a scaffold
Rig life belts and nets

Unit: Equipment Maintenance

Competency: Perform housekeeping

Competency Builders:

Dispose of scrap metal chips, shavings, trash and waste
Clean work area
Store hand tools, cutters, fixtures, jigs and attachments
Store grinding wheels
Follow tool crib procedures
Inspect machine guards
Replace or adjust machine guards
Report problems to supervisor

Competency: Perform recordkeeping

Competency Builders:

Explain reasons for keeping maintenance records
Explain reasons for keeping cost records
Complete work order
Complete internal requisition
Complete external requisition
Complete time cards
Complete job status reports
Complete equipment failure reports
Record preventive maintenance activities
Record repair activities
Read job orders and process sheets
Locate tooling and set up information
File reports
Prepare new/replacement equipment recommendations

Competency: Inspect machine systems

Competency Builders:

Explain planned maintenance
Explain predictive maintenance measures
Explain preventive maintenance measures (e.g., lubrication)
Log machine histories
Explain machine system(s) calibration
Inspect linkages and lever mechanisms
Inspect drive couplings
Inspect clutches
Inspect roller ball bearings
Inspect safety systems
Analyze system failure
Make minor adjustments/repairs
Coordinate maintenance services

Competency: Perform machine maintenance

Competency Builders:

Use operator's and manufacturer's manuals
Operate individual machines
Diagnose malfunctions
Apply lockout/tagout procedure
Disassemble defective section
Clean equipment
Lubricate equipment
Check equipment for wear and alignment
Repair or replace defective parts
Test machine for performance
Make minor adjustments to equipment
Prepare planned maintenance schedules
Explain breakdown maintenance

Competency: Maintain hand tools

Competency Builders:

Demonstrate use and care of measuring devices (e.g., rules, tapes, calipers, micrometers, multimeter, thermometer, and coordinate measuring system)
Demonstrate use and care of equipment used to bend and assemble rigid conduit and tubing
Demonstrate use and care of common hand tools
Demonstrate use and care of wood working tools (e.g., saws, planes, drills, hammers)
Demonstrate use and care of sheet metal tools (e.g., sheet metal gauges, hand seamers, soldering irons)
Demonstrate use and care of ropes, slings, pullers, and block and tackle
Demonstrate proper metal working bench skills (including use of vices, hacksaws, files, tapes, dies, and reamers)
Demonstrate use and care of pipe clearing equipment

Competency: Maintain portable power tools

Competency Builders:

Demonstrate use and care of light-duty and heavy-duty drills
Demonstrate use and care of electric hammers
Demonstrate use and care of pneumatic drills and hammers
Demonstrate use and care of power screwdrivers and impact wrenches
Demonstrate use and care of linear motion saws
Demonstrate use and care of circular saws
Demonstrate use and care of routers and planes
Demonstrate use and care of belt, pad and disc sanders
Demonstrate use and care of grinders and shears
Demonstrate use and care of explosive actuated tools
Demonstrate use and care of electric lifts

Competency: **Maintain stationary equipment**

Competency Builders:

Demonstrate use and care of mechanical presses
Demonstrate use and care of hydraulic presses
Demonstrate use and care of drill presses
Demonstrate use and care of bench grinders
Demonstrate use and care of power saws (e.g., hack, cut-off, chop, band, jig, and table)
Demonstrate use and care of band saws
Demonstrate use and care of pipe threaders
Demonstrate use and care of metal brakes
Demonstrate use and care of power shears

Unit: Mechanical Power Transmission

Competency: Demonstrate knowledge of basic mechanics

Competency Builders:

Explain working forces of torque, tension, and compression
Explain the laws of motion
Explain how to calculate work in several ways
Explain the function of simple machines including levers, inclined plane, wedge wheel and axle, pulley and screw, gears
Explain the types of power and the method of producing power
Explain the laws of friction
Explain mechanical efficiency
Apply basic knowledge of physics
Apply basic knowledge of stress, strain, and fatigue
Calculate speed changes

Competency: Describe mechanical power transmission systems

Competency Builders:

Describe the principles and operation of compound and reverted gear trains
Describe the principles and operation of internal and planetary gear trains
Describe the principles and operation of helical and bevel gear trains
Describe the principles and operation of rack and pinion, worm and wheel, and block and screw mechanisms
Describe the principles and operation of counter rotating mechanisms and differentials
Describe the principles and operation of spring mechanisms, pulley blocks and differentials
Describe the principles and operation of chain, belt and disc drives and universal joints
Describe the principles and operation of clutch and coupling mechanisms
Describe the principles and operation of braking mechanisms
Describe the necessity for proper alignment and fit of mechanical devices
Describe the necessity for proper balance of system components
Describe proper component matching (e.g., sheave sets, gear sets)

Competency: Use bearings

Competency Builders:

Define bearing
Identify types of bearings and their applications
Identify installation method
Install bearings
Maintain bearings (e.g., lubrication)
Remove bearings
Identify bearing failure modes

Competency: Use seals

Competency Builders:

Define seal
Identify types of seals and their applications
Identify installation method
Install seals
Maintain seals
Remove seals
Identify failure modes

Competency: Use gears

Competency Builders:

Define gears
Identify types of gears, their materials, and their applications
Identify installation method
Install gears
Maintain gears (e.g., lubrication)
Remove gears
Identify failure modes

Competency: Use sheaves

Competency Builders:

Define sheaves
Identify types, tolerances, and materials of sheaves and their applications
Identify installation method
Install sheaves
Maintain sheaves
Remove sheaves
Identify failure modes

Competency: Use belts and pulleys

Competency Builders:

Define belts and pulleys
Identify types of belts and pulleys and their applications
Identify installation method
Install belts and pulleys
Maintain belts and pulleys
Remove belts and pulleys
Identify failure modes

Competency: Use sprockets and chains

Competency Builders:

Define sprockets and chains
Identify types of sprockets and chains and their applications
Identify installation method
Install sprockets and chains
Maintain sprockets and chains
Remove sprockets and chains
Identify failure modes

Competency: Use cams and levers

Competency Builders:

Define cams and levers
Identify types of cams and levers and their applications
Identify installation method
Install cams and levers
Maintain cams and levers
Remove cams and levers
Identify failure modes

Competency: Use clutches and brakes

Competency Builders:

Define clutches and brakes
Identify types of clutches and brakes and their applications
Identify installation
Install clutches and brakes
Maintain clutches and brakes
Remove clutches and brakes
Identify failure modes

Competency: Install drive components

Competency Builders:

Identify types of couplings and their applications
Install solid coupling
Install jaw coupling
Install molded rubber coupling
Install chain type coupling
Install a clutch
Install brakes
Align bearings, bushing, and cams
Install V-belts and adjust tensions
Install a V-belt and manually adjustable sheaves
Adjust a V-belt and manually adjustable sheaves
Install a V-belt with spring loaded adjustable sheaves
Explain the purposes and advantages of a chain drive system
Explain the function of speed reducers
Explain the function of gears and variable speed reducers
Install shafts
Align shafts
Mount drive sprockets and chains
Mount sheaves and pulleys
Mount gears on open gear drives
Align gears on open gear drives
Install a mechanical clutch system
Install adjustable speed drives
Troubleshoot adjustable speed drives
Explain the operation of fluid couplings
Install fluid couplings
Install torque converters
Perform preventive maintenance on drive components
Inspect completed work
Describe types of fit and tolerances
Explain importance of balance

Competency: **Describe the operation of mechanisms, linkages and levers**

Competency Builders:

Describe class one, two, three, and compound levers
Describe the principles and operation of rocker arm and bell crank linkages and combined mechanisms
Describe the principles and operation of four-bar mechanisms (crank, rocker, and double rocker)
Describe the principles and operation of drag link and intermediate mechanisms
Describe the principles and operation of four-bar variations
Describe the principles and operation of cam mechanisms
Describe the principles and operation of pivoted follower mechanisms
Describe the principles and operation of toggle, quick return, and ratchet mechanisms
Describe the principles and operation of geneva mechanisms

Competency: **Apply knowledge of lubricants**

Competency Builders:

Explain the function of lubricants
Explain the properties of oil lubricants and factors determining the selection of lubricants
Identify types and functions of lubricant additives
Describe types of circulating oils and their purposes
Describe lubricating systems, including the charts and methods used
Demonstrate proper grease application
Demonstrate proper lubricant storage and handling
Lubricate a piece of industrial equipment
Identify specified lubricant or equivalent
Explain lubricant recovery and disposal
Explain use of oil analysis reports

Unit: Electromechanical Technology

Competency: Interpret electromechanical drawings

Competency Builders:

Identify types of drawings and their applications
Transfer measurements
Explain the use of auxiliary views, revolutions, and sectional views
Describe dimensioning practices and techniques on drawings
Interpret mechanical/electronic production and assembly drawings

Competency: Describe the operation of electronic sensors and transducers

Competency Builders:

Explain temperature transducers operation
Explain stress and strain transducers operation
Explain magnetic transducers operation
Explain liquid and fluid flow transducers operation
Explain fiber optic system operation

Competency: **Demonstrate proficiency in transducers (sensors) and instrumentation**

Competency Builders:

Describe characteristics associated with transducers and instrumentation
Describe the principles and operations of various types of transducers (e.g., thermal, shock/vibration, acceleration, positional, pressure, flow, optical, gas and humidity)
Demonstrate the use of various transducers (e.g., thermal, shock/vibration, acceleration, positional, pressure, flow, optical, gas and humidity)
Troubleshoot transducers
Differentiate among thermocouple types
Interpret specifications of temperature sensors (e.g., thermocouples, thermistors, resistance temperature devices)
Interpret specification of pressure sensors (e.g., strain gage, piezzo electric/piezzo resistive) to electrical circuits
Interpret specifications of flow sensors (e.g., orifice flow meter, turbine meter, mass flow meters)
Interpret specifications of speed or position sensor (e.g., tachometer, resolver encoder, linear voltage differential transformer (LVDT)
Interpret specifications of controllers, indicators, and recorders (e.g., process controllers, programmable logic controllers with interfaces, R-chart recorders, dataloggers/indicators)
Interpret specifications of final control elements (i.e., silicon controlled rectifiers (SCR), power controllers, motor drives, actuators/robots)
Describe application circuits
Calculate specification of proximity sensors
Calculate specifications of infrared and photo-sensors
Explain use of proximity sensors
Explain use of photo electric sensors
Explain use of mechanically activated switches
Troubleshoot switch failure
Describe transducer control and measurement circuits
Demonstrate the use of control and measurement circuits
Troubleshoot control and measurement circuits

Competency: **Demonstrate proficiency in power distribution systems**

Competency Builders:

Describe power distribution systems
Describe poly-phase distribution systems
Describe single-phase distribution systems
Describe DC distribution systems
Describe delta distribution systems
Describe wye distribution systems
Describe medium-voltage distribution systems (less than 600v)
Troubleshoot poly-phase distribution systems
Troubleshoot single-phase distribution systems
Troubleshoot DC distribution systems
Troubleshoot delta distribution systems
Troubleshoot wye distribution systems
Troubleshoot medium-voltage distribution systems

Competency: **Demonstrate proficiency in power distribution equipment**

Competency Builders:

Describe power transformers
Describe power capacitors
Describe power oil switches and cutouts
Describe application of NEMA or IEC controls
Describe different types of enclosures for controls
Describe current transformers
Describe potential transformers
Describe medium-voltage circuits breakers and fuses
Use medium-voltage safety equipment
Troubleshoot power transformers
Troubleshoot power capacitors
Troubleshoot power oil switches and cutouts
Troubleshoot current transformers
Troubleshoot potential transformers
Troubleshoot medium-voltage circuit breakers and fuses

Competency: Demonstrate proficiency in motors and motor control

Competency Builders:

Test solid state components with ohmmeter
Test solid state DC motor control circuits
Test solid state AC motor control circuits
Calibrate or recalibrate equipment
Identify SCR and TRIAC AC control circuits
Explain how load is connected to 3-phase wye configured AC generator
Identify wye connected and delta connected 3-phase motors
Explain revolving fields in AC motors
Describe operation of common AC motors
Describe operation of variable frequency AC drives
Define advantages and disadvantages of common DC motors
Explain how motor load affects speed regulation
Describe operation of stepper motors
Describe speed control of various types of motor drives using sensors
Identify defective motors
Describe regenerative dynamic breaking
Describe operation of various feedback loops

Competency: Apply quality control techniques

Competency Builders:

Perform preventive maintenance
Perform predictive maintenance
Apply statistical process control (SPC)
Recalibrate equipment
Apply problem-solving tools and techniques

Competency: **Apply electromechanical maintenance management practices**

Competency Builders:

Keep maintenance records
Complete work order
Complete internal requisition
Complete external requisition
Explain planned maintenance
Explain breakdown maintenance
Explain predictive maintenance
Establish maintenance schedules
Explain reasons for keeping maintenance records
Explain reasons for keeping cost records
Analyze system failure
Make minor adjustments/repairs
Coordinate maintenance service
Make new/replacement equipment recommendations
Interpret bill of materials for allocation, stocking, and raw material information
Analyze use of bill of materials for workplace decision making

Unit: Precision Machining

Competency: **Perform prerequisite machining skills**

Competency Builders:

Demonstrate maintenance of immediate work area, machinery, tools and gages
Demonstrate proficiency in interpreting prints/drawings
Demonstrate proficiency in planning work sequence/set up
Follow safety rules and regulations for each machine

Competency: **Analyze machine shop jobs**

Competency Builders:

Identify sequence of work on specified project(s)
Identify tolerances and finishes on specified project(s)
Identify variables that effect job efficiency (e.g., speeds, feeds)
Use Machinery Handbook
Identify causes of workpiece defects

Competency: **Achieve machine shop job standards**

Competency Builders:

Write machine shop job procedure
Complete machine shop job status report(s)
Analyze machine shop job evaluation data

Competency: Perform bench operations

Competency Builders:

Use measuring instruments and hand tools
Deburr workpiece
Lay out workpiece
Drill hole
Hand tap hole
Cut threads with die
Apply basic metallurgy knowledge

Competency: Operate metal cutting saw

Competency Builders:

Identify types and uses
Identify proper cutting fluids
Transfer dimensions from blueprint
Clean metal cutting saw
Lubricate metal cutting saw
Install guides
Adjust guides
Select proper blades
Weld saw blade
Install saw blade
Select speeds and feeds
Cut metal
Deburr workpiece
Apply basic metallurgy knowledge

Competency: Operate drill press

Competency Builders:

Clean drill press
Lubricate drill press
Identify proper cutting fluid
Mount part
Select proper bit, speed, and feed
Demonstrate proper bit sharpening techniques
Drill part
Countersink
Tap hole
Apply basic metallurgy knowledge

Competency: Operate tool and cutter grinding machine

Competency Builders:

Identify parts of machine
Identify proper cutting fluids
Identify causes of workpiece defects
Select proper wheels and work holding devices (e.g., superabrasives)
Perform truing operations
Perform dressing operations
Perform forming operations
Select proper speeds and feeds
Sharpen end mill
Sharpen horizontal milling cutter
Sharpen drills and countersinks
Apply basic metallurgy knowledge

Competency: Operate pedestal grinder

Competency Builders:

Clean pedestal grinder
Lubricate pedestal grinder
Identify proper wheel
Identify proper coolant
Check wheel for defects
Mount wheel
Position guard and rest
Dress wheel
Sharpen drill bit
Apply basic metallurgy knowledge

Competency: Operate lathe

Competency Builders:

Clean and lubricate lathe
Identify proper cutting fluid
Identify proper tools and holders
Sharpen tools properly
Mount workpiece
Use dial indicator
Position guards
Select feed(s) and speed(s)
Face workpiece
Turn shaft
Turn taper
Knurl workpiece
Cut off workpiece
Deburr
Demonstrate use of a 4-jaw chuck
Center drill hole
Cut threads (inside and outside)
Turn inside bore
Demonstrate use of steady rest
Demonstrate use of centers
Apply basic metallurgy knowledge

Competency: Operate milling machine

Competency Builders:

Clean milling machine
Lubricate milling machine
Identify proper cutting fluid
Select proper tool
Select proper feeds and speeds
Type of cut (e.g., climb, std.)
Mount workpiece
Mount tool
Mill surface
Mill keyway
Drill workpiece
Bore with milling machine
Mill angle
Apply basic metallurgy knowledge

Competency: Operate surface grinder

Competency Builders:

Clean surface grinder
Lubricate surface grinder
Identify proper cutting fluid
Select proper wheel
Select proper speeds and feeds
Check wheel for defects
Mount wheel
Position guard
Dress wheel
Identify proper mounting techniques
Mount workpiece
Set surface grinder
Apply basic metallurgy knowledge

Competency: Select materials for job

Competency Builders:

Interpret color codes, numbering systems, and classification systems of materials (i.e., ANSI, SAE)
Identify metals using spark test
Identify metals using variety of tests
Identify materials
Apply basic metallurgy knowledge

Competency: Perform heat treatment and testing of metals

Competency Builders:

Test hardness of metals
Perform non-destructive testing
Perform destructive testing
Harden metals to job specifications
Temper metals to job specifications
Anneal metals to job specifications
Normalize metals to job specifications
Case harden metals to job specifications

Competency: Explain nontraditional machining processes

Competency Builders:

Describe principles of chemical etching
List applications of chemical etching
List advantages/disadvantages of chemical etching
Describe principles of photochemical etching
List applications of photochemical etching
List advantages/disadvantages of photochemical etching
Describe electrical-discharge machining (EDM)
List applications of EDM
Differentiate between EDM and wire EDM
List applications for wire EDM
Describe principles of electrochemical machining
List applications of electrochemical machining
List advantages/disadvantages of electrochemical machining
Describe principles of water jet cutting
List applications of water jet cutting
Describe principles of torch cutting
List applications of torch cutting
Describe principles of laser cutting
List applications of laser cutting
List advantages/disadvantages of laser cutting
Describe shot peen
Describe media finish
Describe glass bead
Describe principles of laser welding

Competency: Perform precision layouts

Competency Builders:

Identify appropriate tools for measuring
Describe precision, accuracy, tolerance, reliability, and discrimination
Distinguish between precision and semiprecision measuring
Define standard stock dimensions and tolerances
Demonstrate knowledge of different units of measure (metric, standard, inches, etc.)
Describe common measurement errors and correction procedures
Calibrate measuring machines and devices
Demonstrate care of measuring instruments
Demonstrate use of rule
Demonstrate use of tape
Demonstrate use of pi tape
Demonstrate use of combination square
Demonstrate use of calipers
Demonstrate use of micrometers (inside and out)
Demonstrate use of dial indicators
Demonstrate use of sine bar
Demonstrate use of gauges (e.g., dial bore, dial snaps)
Demonstrate use of surface plate
Demonstrate use of protractor
Explain use of profilometer
Demonstrate use of thermometer
Demonstrate use of dividers
Demonstrate basic use of gauge blocks
Demonstrate use of threading specs
Explain use of optical comparitor
Explain use of digital instruments
Explain use of electronic gauging equipment
Explain use of data acquisition equipment
Explain operation of manual coordinate measuring machine (CMM)
Explain use and application of laser alignment/measurement

Unit: Fundamentals of Machine Anatomy

Competency: Interpret specifications for a machine

Competency Builders:

Identify power source
Identify power transmission
Identify hydraulic/pneumatic actuators
Identify materials
Identify fits/tolerances
Identify GD&T symbols
Identify safety factors
Participate in concurrent engineering
Demonstrate knowledge of print reading

Competency: Build a machine to specifications

Competency Builders:

Install hydraulic and pneumatic actuators
Troubleshoot hydraulic and pneumatic actuators
Install motors
Troubleshoot motors
Install sensors
Troubleshoot sensors
Install PLC's
Troubleshoot PLC's
Install industrial controls
Troubleshoot industrial controls
Install power distribution systems
Troubleshoot power distribution systems
Install brakes and clutches
Troubleshoot brakes and clutches
Install lubrication system
Troubleshoot lubrication system

Unit: Hydraulics and Pneumatics

Competency: Describe fluid flow concepts

Competency Builders:

Explain Pascal's Law
Explain Boyle's Law
Explain Bernoulli's Principle
Describe flow velocity
Explain how heat and pressure relate to power and transmission
Describe physical and chemical properties of a fluid
Describe fluids in motion in closed conductors
Describe continuity of mass flow
Identify types of fluids
Identify properties of fluids
Identify English and metric units of measurement for pressure, density, and viscosity

Competency: Describe energy considerations

Competency Builders:

Differentiate work and power
Differentiate potential and kinetic energy
Explain energy conservation concept
Explain hydraulic horsepower
Explain work of compression in compressible fluids

Competency: Describe system losses

Competency Builders:

Differentiate turbulent and laminar flow
Explain friction factor
Explain pressure losses
Identify potential system losses (e.g., leaks, wear, component sizing, heat, dirt)

Competency: Describe hydrostatics

Competency Builders:

Explain pressure, density, and viscosity
Explain buoyancy
Explain equilibrium

Competency: Calculate energy

Competency Builders:

Apply Pascal's Law
Apply Bernoulli's Principle
Apply Boyle's Law
Calculate work and power
Calculate potential and kinetic energy
Calculate hydraulic horsepower
Calculate flow velocity and pressure
Calculate pressure losses
Calculate laminar flow
Calculate pump capacity
Calculate system requirements

Competency: Design basic hydraulic/pneumatic system

Competency Builders:

Use common symbols
Create circuit diagrams (i.e., schematics)
Diagram closed-loop hydraulic system
Diagram an air supply system

Competency: Describe component operation

Competency Builders:

Identify functions and operation of hydraulic components
Identify functions and operation of pneumatic components
Explain application(s) of different materials (e.g., plastic, copper)

Competency: Interpret hydraulic and pneumatic schematics

Competency Builders:

Identify common symbols
Sketch circuit diagrams (i.e., schematics)
Interpret circuit diagrams (i.e. schematics)
Sketch circuit analysis
Diagram an air supply system

Competency: Troubleshoot hydraulic and pneumatic circuits

Competency Builders:

Analyze hydraulic circuits
Troubleshoot hydraulic circuits
Analyze pneumatic circuits
Troubleshoot pneumatic circuits

Competency: Perform pump maintenance and repair

Competency Builders:

Identify types and operating features of pumps
Identify pump capacity and system requirements
Explain packing and seal requirements
Explain operating principles of pumps (e.g., centrifugal, propeller and turbine rotary, metering)
Perform pump maintenance
Disassemble a pump
Reassemble a pump

Competency: **Maintain piping and accessories for high and low pressure fluid power systems**

Competency Builders:

Identify components of a piping system
Explain maintenance features of both metallic and non-metallic piping systems
Explain types of values and their operation and maintenance
Explain use and maintenance of strainers, filters, and traps in piping systems
Join common fittings
Join metallic pipe
Join plastic pipe
Join copper and steel tubing
Bend copper and steel tubing
Cut copper and steel tubing
Flare tubing

Competency: **Maintain hydraulic system components**

Competency Builders:

Install a contaminant removal system
Maintain a contaminant removal system
Explain operation and use of heat exchanges
Identify reservoir requirements
Compute hose requirements
Install hydraulic lines
Select control valves and servo-type valves
Install control valves and servo-type valves

Competency: Troubleshoot hydraulic systems

Competency Builders:

Interpret hydraulic schematic
Identify causes of failure modes
Connect electrically controlled valves
Explain hydraulic system troubleshooting techniques
Repair or replace hydraulic valves
Repair or replace hydraulic cylinders
Repair or replace hydraulic pumps and motors
Install hydraulic components

Competency: Describe reciprocating and rotary air compressors

Competency Builders:

Explain relationship of force, weight, mass, and density in pneumatic system
Explain operation of reciprocating compressors
Explain operation of rotary compressors
Explain primary and secondary air treatment (e.g., air dryers, lubricating systems)
Explain operation of compressor valves, cylinders, and motors

Competency: Maintain pneumatic systems

Competency Builders:

Install pneumatic system components
Explain pneumatic system maintenance techniques
Explain pneumatic system troubleshooting procedures
Isolate faults in air compressors
Repair or replace air compressors
Isolate faults in control valves
Repair or replace control valves
Isolate faults in air motors
Repair or replace air motors
Isolate faults in air dryers
Repair or replace air dryers
Maintain proportioning and servo valves

Competency: Troubleshoot pneumatic systems

Competency Builders:

Interpret pneumatic schematic
Diagram an air supply system
Install pneumatic system components
Explain pneumatic system troubleshooting procedures
Troubleshoot air compressors
Troubleshoot pneumatic control valves
Troubleshoot air motors
Troubleshoot air dryers

Competency: **Maintain vacuum systems**

Competency Builders:

Describe characteristics associated with vacuum systems and sub atmospheric pressure
Describe the principles and operation of vacuum gauges
Demonstrate use of vacuum gauges
Repair or replace vacuum gauges
Describe the principles and operation of vacuum pumps
Demonstrate use of vacuum pumps
Repair or replace vacuum pumps
Describe the principles and operation of vacuum controls
Demonstrate use of vacuum controls
Repair or replace vacuum controls

Unit: Industrial Manufacturing Technology

Competency: Describe industrial manufacturing process

Competency Builders:

Demonstrate use and maintenance of personal protective equipment
Explain techniques of measuring motion, forces, voltage, current, power, distance, time and temperature
Explain mechanical and chemical properties of ferrous and non-ferrous metals
Explain industrial manufacturing process
Explain industrial use of non-metallic solids (e.g., ceramics, polymers), liquids, and gases
Develop flow chart and process sheets
Draft preventive maintenance and calibration procedures
Explain need for manufacturing documentation (e.g., ISO 9000)
Define quality process

Competency: Demonstrate knowledge of materials requirements planning

Competency Builders:

Define materials requirements planning
Explain importance of maintaining and controlling inventory (e.g., quantity, price, quality, minimal lot sizes, and timeliness)
Define master production schedule and bill of materials
Explain inventory carrying cost and economic order quantity
Describe the use of the computer in MRP
Calculate net requirements

Competency: Demonstrate knowledge of supply materials

Competency Builders:

Describe role of purchase requisitions
Describe role of material specifications
Describe role of quality parameters
Define supplier certification rating methods
Describe role of source inspector
Describe role of receiving

Competency: Demonstrate knowledge of plant layouts

Competency Builders:

Describe the importance of flexibility
Differentiate among product layout, process layout, fixed position layout, and cellular layout
Describe the type of production suited to each layout
Describe advantages and disadvantages of each layout

Competency: Demonstrate knowledge of material flow

Competency Builders:

Describe importance of flexibility
Differentiate straight-line, U-shaped, S-shaped, convoluted and comb patterns
Describe advantages and disadvantages of each pattern

Competency: Maintain quality control of materials handling

Competency Builders:

Maintain system for physical handling and movement of material in-process and in-storage
Monitor system of physical handling and movement of material in-process and in-storage
Maintain system for physical handling and movement of finished products
Monitor system of physical handling and movement of finished products
Write requests for deviation from specifications
Implement quality control and inspection standards and procedures
Write engineering change notices and rejection reports
Monitor reports of discrepancy or rejects during production process
Conduct quality tests under different environmental conditions

Competency: Demonstrate knowledge of post-production control

Competency Builders:

Explain importance of product protection, identification and storage
Describe methods of identifying products (e.g., labels, bar codes, radio frequency systems and magnetic strip systems)
Describe manual methods of storage and retrieval
Describe automated storage and retrieval systems (ASRS)
Describe automated guided vehicle moving systems (AGVS)

Competency: Analyze a manufacturing project

Competency Builders:

Explain the "how" of project selection
Explain the "how" of project implementation
Explain the "how" of project evaluation
Explain the "how" of planning continuing improvement
Explain the "how" of planning predictive maintenance

Unit: Programmable Logic Controllers (PLCs)

Competency: Differentiate among process controls

Competency Builders:

Describe characteristics associated with automatic controls
Define proportional control
Define integral control
Define derivative control
Describe advantages of using proportional, integral or derivative control
Describe disadvantages of using proportional, integral or derivative control

Competency: Explain basic operation of PLCs

Competency Builders:

Describe basic applications of PLCs
Identify program symbols and language functions
Describe function of block transfers
Describe operation of timers, counters, and sequences
Describe operation of analog I/O modules
Describe operation of servo motion control
Describe the principles and operation of PLCs

Competency: Demonstrate use of PLCs

Competency Builders:

Draw block diagram of a PLC
Define individual blocks of a PLC
Use operator's and/or manufacturer's manual(s)
Translate relay logic to logic for a PLC
Use function of block transfers
Operate timers, counters and sequencers
Operate analog I/O modules
Operate servo motion control
Install a PLC
Connect controller to sensors
Describe test procedures for new installation of a PLC
Troubleshoot hardware faults on a PLCs
Use safety interlock
Describe use of (Graphic Programmable Panel) GPP
Write a statement and ladder logic program
Document a statement and ladder logic program
Use a PLC program
Troubleshoot a program for a PLC
Repair a program for a PLC

Competency: Apply robot fundamentals

Competency Builders:

Describe the operation of robotic work cells
Operate robotic work cells
Troubleshoot robotic work cells
Repair robotic work cells
Classify robots according to industry criteria
Identify robot power drive types
Describe positioning in terms of axis, actuators and coordinate system
Identify types of control systems and sensors
Apply different methods of programming (e.g., teach, off-line)
Write simple programs to exercise robot functions
Join programs to perform full function
Identify principles of robot safety
Describe operation of various sensors used in robot control
Interface sensors to robot
Interface robots
Define open loop and closed loop control
Design a simple automated system to perform manufacturing operation
Identify operation of end-effectors

Unit: Computerized Numerical Control (CNC)

Competency: Demonstrate knowledge of CNC

Competency Builders:

Define numerical control (NC) and computerized numerical control (CNC)
Differentiate NC and CNC
Describe closed loop, open loop, and adaptive controls
Define point to point systems
Identify tool movement of point to point systems
Define continuous path systems
Identify tool movements of continuous path systems
Identify data input mediums
Explain the purpose of the post-processor
Define canned cycles
Identify computer memory types
Identify information stored relative to computer memory types
Differentiate hardware and software
Differentiate among CNC, machining centers, and robots
List advantages/disadvantages of CNC machining centers
Explain direct numerical control (DNC)

Competency: Perform preventive maintenance

Competency Builders:

Follow proper safety procedures
Clean CNC equipment
Lubricate CNC equipment
Check CNC equipment for wear and alignment

Competency: Apply CNC operations

Competency Builders:

Identify parts of the machine
Apply basic programming skills to a turning and a milling operation
Select proper work holders
Select proper cutting tools
Set machine parts to drawing tolerances
Use CAD/CAM for part program development

Competency: Prepare CNC program

Competency Builders:

Write a program manually in word address format
Write a program off line
Write a program manually in conversational program
Generate a program using CAD/CAM package
Program machine using manual data input (MDI) process

Competency: Program CNC operations

Competency Builders:

Apply ANSI drawing standards
Apply process planning from drawing to finished product
Analyze workpiece
Contrast differences in computer-assisted programming
Perform basic trigonometric computations
Perform special perception mathematical computations
Set chip load, feed rates and surface feet per minute limitations
Turn intersection points into segments (i.e., defined in terms of points, lines, and circles)
Debug program

Competency: Load machine

Competency Builders:

Load program from MDI and off-line programming station
Prepare work-holding device
Mount work-holding device
Secure workpiece
Set up reference and clearance points
Set up tooling
Select proper lubrication/coolant

Competency: Operate CNC machine

Competency Builders:

Load raw material
Start cycle
Monitor work in-process
Edit CNC programs
Demonstrate ability to halt running program
Apply proper safety procedures
Demonstrate proper cleaning of CNC machine

Competency: Manufacture workpiece (e.g., rectangular, round, angular)

Competency Builders:

Dry-run machine
Run part
Inspect part

Unit: Industrial Engineering Basics

Competency: Apply knowledge of workstation design

Competency Builders:

Participate in development of overall plant layout
Assure minimal movement of materials and parts throughout production line
Plan operator's access to materials and tools
Assure operator never reaches across moving machine part
Eliminate unnecessary body moves (e.g., bends, turns, stoops, hand movements)
Assure physical safety of operator (e.g., equipment, temperature, fumes, light)
List type of material handling equipment for operation
Calculate bench space needs for process and storage
Calculate machine controls to position operator efficiently
Physically simulate operation
Review total process for simplification

Competency: Demonstrate knowledge of ergonomics

Competency Builders:

Define ergonomics
Identify risk factors
Define maximum permissible limit (MPL) and action limit (AL) for lifting
Define cumulative trauma disorder (CTD)
Identify susceptibility factors for CTD
Identify need for mats and footrest for standing jobs
Identify need for appropriate working heights of chairs, stools, workbenches, equipment
Identify need for adequate lighting
Explain use of anthropometric design
Explain use of rest pauses
Minimize extreme joint movement
Minimize use of excessive muscle force
Minimize repetitive tasks
Minimize mechanical stresses (e.g., sharp edges, heat, cold, hard surfaces, weights, vibration)
Minimize awkward body positions

Competency: Apply knowledge of methods engineering

Competency Builders:

Define methods engineering
Define goals of methods engineering (i.e., quality, increase productivity, decrease per unit cost)
Set sequence of production operations
Set sequence of needed inspections
Recommend methods to shorten process time
Recommend alternate operations
Recommend ways to eliminate operations
Ascertain if operations can be performed within facilities
Test machine capability
Follow documentation procedures

Competency: Apply knowledge of standards engineering

Competency Builders:

Estimate times by computer simulation
Use predetermined time system (e.g., MTM family)
Use work sampling
Define reach, grasp, move position, turn, apply pressure, and release
Define standard time
Define performance rating
Define allowances
Identify leveling factors (e.g., skill levels, effort, work area conditions, consistency)
Identify allowance factors (e.g., fatigue, delay, personal)
Calculate production rate
Write job description data
Complete job status reports
Analyze job evaluation data

Unit: Basic Materials Science

Competency: Demonstrate basic knowledge of metallurgy

Competency Builders:

Define metallurgy
Define metal forming (e.g., general process)
Identify forming industries (e.g., stamping, forging, fabricating)
Describe metal forming principles
Describe the metal forming process
Identify frequently used metals
Describe the crystalline structures of metals
Use periodic chart to evaluate metals
List chemical properties of common metals
List physical properties of common metals
Describe measures of metal strength
Identify examples of raw materials processed by hot rolling, cold rolling, forging, drawing, extrusion, spinning and powered metallurgy
Explain secondary finishing operations (e.g., paint, anodizing)

Competency: Demonstrate basic knowledge of heat treatment

Competency Builders:

Describe process of heat treating
Define types of heat treating (e.g., case hardening, annealing, drawing, stress relieving, tempering, quenching, critical temperature)

Competency: **Demonstrate basic knowledge of metal characteristics and formability**

Competency Builders:

Explain metal and formability basics
Explain metal grades and coatings
Explain part contour analysis
Explain tensile test
Explain LDH test
Explain bend test
Explain hold expansion test
Explain R-value test
Explain hardness test
Explain cup test
Explain friction test
Explain surface test
Explain interpretation of metal characteristics tests
Describe blank/die interactions (e.g., friction)
Describe friction and forming process
Describe circle grid basics
Describe circle grid applications
Describe formability diagnostics
Describe the documentation process

Competency: **Demonstrate basic knowledge of casting**

Competency Builders:

Identify frequently used metals
Describe crystalline structures of metals
Use periodic chart in evaluating metals
List chemical properties of common metals
List physical properties of common metals
Define permanent mold casting
Define shell mold casting
Define sand casting and pattern making
Define die casting
Identify basic casting terms
Identify advantages/disadvantages of casting processes

Competency: **Demonstrate basic knowledge of iron and its alloys**

Competency Builders:

Define iron and its alloys
Describe iron manufacturing process
Describe the structure of iron and its alloys
List chemical properties of iron and its alloys
List physical properties of iron and its alloys
Describe iron and alloys property variables
Describe measures of strength for iron and its alloys
Identify examples of iron and its alloys processed by hot rolling, stamping, cold rolling, drawing, extrusion, spinning, casting, forging and machining
Perform tensile test
Perform Brinell test
Perform chemical analysis

Competency: **Demonstrate basic knowledge of aluminum and its alloys**

Competency Builders:

Define aluminum and its alloys
Describe aluminum manufacturing process
Describe the structure of aluminum
List chemical properties of aluminum
List physical properties of aluminum
Describe aluminum property variables
Identify examples of aluminum processed by cold rolling, drawing, extrusion, stamping, spinning, casting, forging and machining
Perform tensile test
Perform Brinell test
Perform chemical analysis

Competency: **Demonstrate basic knowledge of copper and its alloys (e.g., brass, bronze)**

Competency Builders:

Define copper and its alloys
Describe copper manufacturing process
Describe the structure of copper
List chemical properties of copper
list physical properties of copper
Describe copper property variables
Describe measures of copper strength
Identify examples of copper processed by cold rolling, drawing, extrusion, stamping, spinning, casting, forging and machining
Perform tensile test
Perform Brinell test
Perform chemical analysis

Competency: **Demonstrate basic knowledge of plastics and polymers**

Competency Builders:

Define thermo-analysis testing (e.g., melt flow, moisture control)
Define plastics and polymers
Describe plastics and polymers manufacturing processes
Describe structure of plastics and polymers
List chemical properties of plastics and polymers
List physical properties of plastics and polymers
Differentiate thermoset and thermoplastic
Describe plastics and polymer property variables
Describe measure of plastic and polymer strength
Identify examples of raw materials processed by machining, extrusion, stamping, injection molding, compression molding and injection compression molding
Identify molding defect (e.g., flash, sink marks, warp, contamination, wet material, stuck parts, short shot, burn marks, surface blemishes)
Identify secondary operations performed on plastic parts (e.g., plating, milling, painted)
Perform tensile test
Perform R-value test

Competency: **Demonstrate basic knowledge of concrete and other ceramics**

Competency Builders:

Explain concrete tools and applications (e.g., float, chairs)
Describe the formation of concrete
List types of cements and their uses
Define qualities of concrete (i.e., strength, consistency, homogeneity, tensile force, abrasion, heat of hydration, and heat and sulfate resistance)
List tests used in concrete production (e.g., slump test, test of fineness modules)
List protective practices used after pouring

Competency: **Demonstrate knowledge of corrosion and protection**

Competency Builders:

Identify causes of corrosion
Identify types of corrosion
List solutions to minimize problems
Identify corrosion testing

Competency: **Demonstrate basic knowledge of rubber manufacturing**

Competency Builders:

Explain history of rubber industry
Compare properties of natural rubber with those of synthetic rubber
Explain how natural rubber is manufactured
Explain vulcanizaton, mastication, and cure systems
Explain use of compounding ingredients (e.g., carbon blacks, accelerators, fillers, antioxidants)
Explain press and autoclave curing
Explain how synthetic rubber is manufactured (e.g., neoprene, butyl, styrene-butadiene)
Explain rubber testing (e.g., tensile, durometer)

Unit: Welding Basics

Competency: **Perform basic gas welding, brazing, and cutting**

Competency Builders:

Follow safety guidelines
Differentiate welding and brazing
Identify gas welding and cutting equipment and accessories
Use personal protective equipment required for welding and cutting
Explain capillary attraction as it applies to metal
Demonstrate proper lighting, adjusting, and shutting down of gas torch
Layout mild steel
Cut mild steel
Braze mild steel
Solder non-ferrous metals
Apply basic metallurgy technology

Competency: **Perform basic arc welding/cutting (i.e., stick)**

Competency Builders:

Identify arc welding equipment and accessories
Explain process of resistance welding
Explain process of projection welding
Explain process of flash-butt welding
Explain process of laser welding
Explain process of friction welding
Explain process of spot welding
Explain process of shielded metal-arc welding (SMAW)
Explain process of gas metal-arc welding (GMAW)
Explain process of gas tungsten-arc welding (GTAW)
Explain process of plasma-arc cutting
Explain process of carbon arc gouging and cutting
Explain process of welding plastics
Explain welding rod alloys
Read welding rods
Explain mild steel welding rod
Explain low hydrogen welding electrode
Explain rationale for preheating and post-heating metal
Explain (GMAW) welding in flat, horizontal, vertical positions
Explain (GTAW) welding on mild steel, stainless steel, and aluminum
Explain process of build up and hard facing
Troubleshoot fusion of materials
Weld stainless steel using (SMAW) process
Weld steel requiring preheat
Weld cast iron
Weld aluminum
Apply basic metallurgy technology

Unit: Metal Stamping Dies

Competency: Describe different types of dies

Competency Builders:

Describe crimping die
Describe parts assembly die
Describe CAM bending die
Describe blanking die
Describe pierce die
Describe forming die
Describe draw die
Describe progressive die

Competency: Describe fixtures

Competency Builders:

Describe crimping fixture
Describe locating fixture
Describe press fitting fixture
Describe riveting fixture
Describe welding fixture

Competency: Design product

Competency Builders:

Draw isometric view of product
Construct model (e.g., clay, form, wood, plastic)
Scan model
Wire frame data
Create computerized model
Interface model with CAD/CAM
Reproduce surface finish
Identify materials for product
Create prototype
Validate product
Standardize product

Competency: Troubleshoot design errors

Competency Builders:

Isolate cause of die component breakage
Isolate cause of failure of parts to be removed from die
Isolate cause of incorrect punch clearance
Isolate cause of incorrect die clearance
Isolate cause of misfitting die components

Competency: Correct design errors

Competency Builders:

Correct cause of die component breakage
Correct cause of failure of parts to be removed from die
Correct cause of improper punch clearance
Correct cause of improper die clearance
Correct cause of misfitting die components

Competency: Explain die processing

Competency Builders:

Describe preplanning activities
Describe die layout
Identify die operations (e.g., number, purpose and sequence of die operations)
Describe feasibility study development
Describe sequence of operations from die construction

Competency: Explain pattern shop applications

Competency Builders:

Describe pattern shop activities
Describe die pattern materials (e.g., wood, styrofoam, ceramic)
Describe die pattern construction
Describe casting of dies
Describe casting of components
Describe model process steps
Describe model use

Competency: Explain die construction (e.g., production and operation techniques)

Competency Builders:

Explain need for basic machining skills
Explain need for sculptured machining skills
Explain EDM functions
Explain die material standards
Describe tool and die welding
Describe punch finishing
Explain lifter/gauging systems
Explain pressure systems
Describe function of cams

Competency: Explain the die tryout process

Competency Builders:

Explain need to use analytical problem solving for die tryout
Describe process documentation
Describe die modification techniques
Describe blank modification techniques
Describe die buy-off
Describe die release
Describe part release
Describe die coatings
Describe die treatments

Competency: Explain die maintenance

Competency Builders:

Describe planned die maintenance
Describe predictive die maintenance
Describe preventive die maintenance
Describe die maintenance troubleshooting techniques
Describe die refurbishment techniques

Unit: Press Technology

Competency: Explain press operation

Competency Builders:

Identify types of presses
Describe functions of presses
Identify capacity of presses
Describe shutheight
Identify operator safety devices

Competency: Demonstrate knowledge of press accessories

Competency Builders:

Describe function of monitors, proximity switches and die protection
Describe function of loaders
Describe function of roller levelers
Describe function of decoilers
Describe function of feeders
Describe function of transfer mechanisms
Describe function of lubricators and coolants
Describe processing of coil steel
Describe use of quick die change
Describe press set-up

Unit: Sheet Metal Fabrication

Competency: **Demonstrate knowledge of sheet metal fabrication**

Competency Builders:

Describe sheet metal fabricated products
Describe press working process
Describe process(es) of straightening metal
Describe metal finishing and coating
Explain bend allowances
Identify materials used for sheet metal fabricaton (e.g., hot roll, cold roll, aluminum, stainless)
Explain process of determining metal thicknesses
Explain process of layout
Explain process of fastening
Explain process of punch and die clearance and alignment
Demonstrate the capability to finish (cleaning, painting, plating)
Demonstrate CADD uses for layout

Competency: **Describe types of metal fabrication manufacturing**

Competency Builders:

Describe shear
Describe press brake
Describe cut-to-length lines
Describe roll forming
Describe CNC turret presses
Describe FMS cells

Competency: **Layout sheet metal**

Competency Builders:

Lay out 90° ells
Lay out 45° and 30° ells
Use radial line development to lay out
Use development by triangulation to lay out

Competency: Fabricate components

Competency Builders:

Layout design
Measure materials
Create pattern and/or prototype
Use hand tools
Cut materials
Form materials
Use fasteners
Spot weld

Competency: Perform sheet metal fabrication

Competency Builders:

Identify sheet metal fabrication jobs
Identify tools (e.g., manual and hand powered) needed
Fabricate round ells
Fabricate tees
Fabricate pyramids
Fabricate cones
Fabricate square to round transitions

TECH PREP

"GET SERIOUS . . . ABOUT SUCCESS"

CADD Technician

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—NOTICE—

Each Tech-Prep Competency Profile developed should respond to the labor market demands of your Tech Prep Consortium. Therefore, the following pages should be examined carefully before being selected for use in TCP Part I. **[See "The TCP Process" for more information.]** For example, in some cases the number of units far exceeds the amount of content that can be covered within a 4 + 2 TPAD Program. All the units listed in this section will not necessarily apply to your situation, nor will all the competencies within each unit be appropriate. Note that several units appear within each specific occupation and would need to only appear once if you are compiling a cluster of occupations. **[See "TCP Matrix" and "How to Use the TCP Binder" for more information.]**

Unit: Communications Literacy

NOTE: This content was extracted from the 9-12 cluster of Ohio's Model Language Arts Program. Due to statewide initiatives other than Tech Prep, this literacy unit was not altered to meet competency-based criteria. Each literacy unit forms a critical link between academic teachers and members of business, industry, and labor. [See "The TCP Process" for more information.]

Subunit: Reading—Structure

Competencies:

RS1 Exhibit knowledge of language structure
RS2 Recognize that there may be more than one interpretation of reading selections
RS3 Recognize various literary devices
RS4 Recognize and discuss literary elements
RS5 Develop and use an increasingly sophisticated vocabulary gained through context
RS6 Apply knowledge of language structure to reading
RS7 Explain why there may be more than one interpretation of reading selections
RS8 Recognize effect of literacy devices on meaning
RS9 Analyze author's use of literary elements
RS10 Recognize relationship of structure to meaning
RS11 Describe various interpretations and meaning levels in reading selections
RS12 Characterize author's use of literary devices
RS13 Characterize use of literary techniques
RS14 Critique a variety of literature with regard to plot, dialogue, theme, setting, and characterization
RS15 Apply an expanding vocabulary gained through reading
RS16 Explain various interpretations and meaning levels in reading selections
RS17 Analyze use of literary techniques (e.g., extended metaphor, simile, personification, hyperbole, pun, alliteration)
RS18 Understand use of literary devices (e.g., irony, satire, allegory, onomatopoeia)
RS19 Analyze and synthesize pieces of literature with regard to plot, dialogue, theme, setting, and characterization

Subunit: Reading—Meaning Construction
Competencies:

RM1	Demonstrate ability to recognize appropriate pre-reading strategies
RM2	Describe effectiveness of a reading selection
RM3	Read to clarify personal thinking and knowledge
RM4	Support interpretation of text by locating and citing specific information
RM5	Develop personal response to a variety of literary works
RM6	Recognize diverse literary interpretations
RM7	Engage in self-selected reading activities
RM8	Confirm and extend meaning in reading by researching new concepts and facts
RM9	Self-monitor and apply corrective strategies when communication has been interrupted or lost
RM10	Use features of literary genres to extend meaning
RM11	Assess effectiveness of a selection read
RM12	Use reading as a possible problem-solving strategy to clarify personal thinking and knowledge
RM13	Use knowledge of semantic elements (e.g., figurative language, denotation, connotation, dialect) to clarify meaning when reading
RM14	Predict, recognize, interpret, and analyze themes based on familiarity with author's work
RM15	Compare and contrast literary genres
RM16	Assess validity and quality of selection read
RM17	Clarify meaning when reading
RM18	Compare personal reaction to critical assessment of a literary selection
RM19	Assess validity of diverse literary interpretations
RM20	Use reference books to find, evaluate, and synthesize information
RM21	Identify tone of a literary work
RM22	Critique validity of diverse literary interpretations
RM23	Integrate personal reaction to and critical assessment of a literary selection

Subunit: Reading—Application
Competencies:

RA1	Select and read material for personal enjoyment and information
RA2	Read a variety of complete, unabridged works
RA3	Employ various reading strategies according to purpose
RA4	Participate in selection of books, materials, and topics for literature study groups
RA5	Develop and apply knowledge of the interrelationship of concepts
RA6	Read selections from a variety of styles and formats, recognizing that style and format influence meaning
RA7	Extend value of reading, writing, speaking, viewing, and listening by pursuing, through reading, new concepts and interests developed as a result of these activities
RA8	Read extensively from a particular author's work and explain elements
of	author's style

Subunit: Reading—Multidisciplinary
Competencies:

RM1	Connect themes and ideas across disciplines through literature
RM2	Read to facilitate learning across curriculum
RM3	Read to develop awareness of human rights and freedom
RM4	Participate actively in a community of learners
RM5	Recognize and explain interaction between literature and various cultural domains (e.g., social technological, political, economic)
RM6	Explore and analyze a variety of cultural elements, attitudes, beliefs, and value structures by men and women of many racial, ethnic, and cultural groups
RM7	Value thinking and language of others
RM8	Relate literature to historical period about which or in which it was written
RM9	Read to facilitate content learning

Subunit: Writing—Structure
Competencies:

WS1	Develop and expand a repertoire of organizational strategies (e.g., narration, comparison/contrast, and description) through a practice and discussion
WS2	Clarify word choice according to audience, topic, and purpose
WS3	Locate and correct errors in usage, spelling, and mechanics using a variety of resources
WS4	Recognize information gained from primary and secondary sources
WS5	Develop writing which contains ordered, related, well-developed paragraphs with sentences of varied lengths and patterns
WS6	Use information from a variety of sources to develop an integrated piece of writing
WS7	Evaluate and revise writing to focus on such things as audience, tone, and purpose
WS8	Recognize differences between documentation and reference list styles
WS9	Develop extended pieces of writing which contain ordered, related, well-developed paragraphs with sentences of varied lengths and patterns
WS10	Select from a repertoire of organization strategies a pattern appropriate to a topic
WS11	Synthesize information from a variety of sources
WS12	Refine word choice and tone according to audience, situation, and purpose
WS13	Appropriately cite information gained from primary and secondary sources
WS14	Use style manuals or software to prepare documentation and reference lists
WS15	Develop effectively organized pieces of expository writing containing strong voice, clear thesis, and well-developed ideas
WS16	Identify organization patterns appropriate to writing topic
WS17	Respond to others' suggested revisions to a writing piece

Subunit: Writing—Meaning Construction

Competencies:

WM1	Demonstrate knowledge of the recursive nature of the writing process by applying it appropriately to various topics, situations, and audiences
WM2	Develop criteria for writing evaluation using scoring guides and peer/teacher assistance to clarify meaning
WM3	Respond to others' suggested revisions to a piece of writing
WM4	Use word processing, graphics, and publishing aids to construct meaning in writing
WM5	Engage in self-initiated writing activities
WM6	Incorporate personal criteria with generally accepted standards for writing evaluation
WM7	Evaluate, analyze, and synthesize information for writing
WM8	Evaluate own writing using personal and established scoring criteria
WM9	Assess personal/peer revisions to a writing piece
WM10	Recognize and refine personal writing styles

Subunit: Writing—Application
Competencies:

WA1 Apply appropriate writing techniques suitable for varied writing tasks
WA2 Use sentence-combining techniques to improve syntactic fluency and maturity
WA3 Write in response to prompted and self-selected topics in practical, persuasive, descriptive, narrative, and expository domains
WA4 Develop personal voice in writing
WA5 Consider audience and purpose for writing
WA6 Develop criteria for selection and potential development of topic
WA7 Write in a journal or learning log to clarify personal thinking and knowledge
WA8 Apply an expanding vocabulary gained through writing
WA9 Make judicious use of reference sources (e.g., dictionary, thesaurus, on-lien data base, encyclopedia)
WA10 Demonstrate, an appreciation for aesthetically pleasing language through word choice and style
WA11 Apply revising and editing strategies needed for writing task
WA12 Vary sentence lengths and patterns
WA13 Refine personal voice in writing
WA14 Vary styles and formats for intended purpose and audience
WA15 Apply criteria for selection and development of topic
WA16 Participate in peer review of writing in progress
WA17 Use transitions between sentences, ideas, and paragraphs in writing
WA18 Revise and edit papers extensively in preparation for presentation/publication
WA19 Develop a variety of genres
WA20 Focus writing and tone on such elements as audience, situation, and purpose
WA21 Develop topic fully and appropriately
WA22 Use writing process to clarify personal thinking and knowledge
WA23 Apply appropriate recursive writing process as suggested by writing task and writer's process
WA24 Develop an extended piece of writing
WA25 Revise writing and tone to assure focus on such elements as audience, situation, and purpose
WA26 Use writing process to write reflectively

Subunit: Writing—Multidisciplinary
Competencies:

WM1	Use writing process for learning across curriculum
WM2	Use writing process to demonstrate knowledge of need for human rights and freedom
WM3	Value and apply collaborative skills in writing process
WM4	Write in response to reading, speaking, viewing, and listening
WM5	Use multidisciplinary resources in writing projects
WM6	Use writing process to facilitate learning across curriculum
WM7	Recognize value of and engage in collaboration in writing process
WM8	Use communication processes to develop a published writing piece in collaboration with others
WM9	Record experiences and observations related to content learning
WM10	Apply collaborative skills in writing process
WM11	Write collaboratively with peers
WM12	Use cross-disciplinary resources in writing projects

Subunit: Listening/Visual Literacy—Structure
Competencies:

LS1	Listen to and view a wide variety of genres
LS2	Become aware of an author's style through listening and viewing a variety of works
LS3	Recognize correct and appropriate grammar, diction, and syntax
LS4	Expand vocabulary through listening to and viewing varied media
LS5	Recognize beauty of language
LS6	Enhance recognition of an author's style through listening and viewing a variety of works
LS7	Recognize use and misuse of language in media
LS8	Refine knowledge of style through listening and viewing multiple works by the same author
LS9	Expand and refine grammar, diction, and syntax through listening
LS10	Compare authors' styles through viewing and listening to their works
LS11	Expand knowledge of complex grammar, diction, and syntax issues

Subunit: Listening/Visual Literacy—Meaning Construction

Competencies:

LM1	Develop critical thinking skills necessary to evaluate media and assess oral presentations
LM2	Compare new oral texts to past experiences and knowledge in order to enhance comprehension
LM3	Recognize how rhythmic patterns, silence, and cadences enhance quality of speech and literature
LM4	Focus listening and viewing on themes and/or plots
LM5	Gather information from listening and viewing experiences to enhance research
LM6	Use critical thinking skills to evaluate media and oral presentations
LM7	Use prior knowledge and experiences to facilitate comprehension of new oral texts
LM8	Identify rhythmic and time patterns in speech and literature
LM9	Identify and analyze themes and/or plots when listening and viewing
LM10	Use information gathered from listening and viewing experiences to expand research
LM11	Enhance use of critical thinking skills to evaluate media and oral presentations
LM12	Consider prior knowledge and experiences when attempting to understand the meaning of new texts
LM13	Appreciate rhythmic and time patterns of speech and literature
LM14	Select viewing and listening materials to support written text
LM15	Evaluate media and oral presentations analytically and critically
LM16	Organize prior knowledge and experiences to comprehend new texts
LM17	Organize and use viewing and listening materials to support written text

Subunit: Listening/Visual Literacy—Application

Competencies:

LA1	Listen attentively during oral reading
LA2	Use media as stimuli for learning and thinking
LA3	Develop knowledge of structure through art, music, and literature
LA4	Use electronic media to enhance and highlight language learning
LA5	Listen and view for entertainment and enjoyment
LA6	Use technology and other media as means of expressing ideas

Subunit: Listening/Visual Literacy—Multidisciplinary

Competencies:

LM1	Facilitate learning across curriculum through critical listening and viewing
LM2	Engage in individual, small-group, and whole-group listening and viewing activities
LM3	Develop language arts (e.g., viewing, listening) projects collaboratively
LM4	Investigate language and cultural differences through listening and viewing activities
LM5	Participate in a community of learners through productive listening

Subunit: Oral Communication—Structure

Competencies:

OS1	Refine oral communication skills
OS2	Demonstrate knowledge of grammar, usage, and syntax when presenting
OS3	Select topics and vocabulary suitable to audience
OS4	Organize notes and ideas for speaking
OS5	Use language imaginatively
OS6	Modulate voice to meaning when interpreting literature orally
OS7	Organize notes and ideas for formal, semiformal and informal presentations of information
OS8	Refine speaking techniques for formal, semiformal, and informal settings
OS9	Develop repertoire of organizational strategies for presenting information orally
OS10	Expand vocabulary to fit topic
OS11	Select topics suitable to audience, situation, and purpose
OS12	Select appropriate strategies when organizing notes and ideas for speaking

Subunit: Oral Communications—Meaning Construction
Competencies:

OM1	Make connections between prior knowledge and new information for oral presentations
OM2	Participate in informal speaking activities
OM3	Use interviewing techniques to gather information
OM4	Communicate orally to entertain and to inform
OM5	Participate in group communication activities
OM6	Take and organize notes when preparing speech/presentation
OM7	Interpret texts orally to illustrate meaning
OM8	Respond to needs of various audiences
OM9	Gather and assess information for speaking
OM10	Communicate orally to inform and persuade
OM11	Prepare and deliver formal speech/presentation
OM12	Participate in a variety of oral interpretations
OM13	Assess needs of audience and adjust language and presentation according to their knowledge
OM14	Analyze and synthesize information for speaking
OM15	Describe effectiveness of literary selection
OM16	Describe topic or idea in order to clarify personal/audience thinking
OM17	Analyze and synthesize information gathered from a variety of sources for speaking
OM18	Describe validity and/or quality of a literary selection and justify selection
OM19	Interpret orally a variety of literature
OM20	Describe topic or idea to clarify meaning for others

Subunit: Oral Communication—Application
Competencies:

OA1	Become proficient at using interviewing techniques
OA2	Give an oral interpretation for a specific audience
OA3	Develop and apply oral communication skills for cooperative/collaborative learning
OA4	Use oral communication for a variety of purposes and audiences (e.g., negotiations, book reviews, rationales)
OA5	Develop and apply decision-making strategies
OA6	Practice interviewing techniques
OA7	Apply interviewing techniques to purposeful interviews
OA8	Focus oral interpretation on a specific audience

Subunit: Oral Communications—Multidisciplinary

Competencies:

OM1	Value thinking and language of others
OM2	Develop oral projects collaboratively
OM3	Be involved in individual, small-group, and whole-group language activities
OM4	Participate actiyely in a community of learners
OM5	Investigate language and cultural differences through oral language activities

Unit: Mathematics Literacy

NOTE: This content was extracted from the 9-12 cluster of Ohio's Model Mathematics Program. Due to statewide initiatives other than Tech Prep, this literacy unit was not altered to meet competency-based criteria. Each literacy unit forms a critical link between academic teachers and members of business, industry, and labor. [See "The TCP Process" for more information.]

Subunit: Numbers and Number Relations
Competencies:

NR1 Compare, order, and determine equivalence of real numbers
NR2 Estimate answers, compute, and solve problems involving real numbers
NR3 Compare and contrast real number system, rational number system, and whole number system
NR4 Extend knowledge to complex number system and develop facility with its operation

Subunit: Measurement
Competencies:

M1 Estimate and use measurements
M2 Understand need for measurement and probability that any measurement is accurate to some designated specification
M3 Understand and apply measurements related to power and work
M4 Understand and apply measurement concepts of distance-rate-time problems and acceleration problems
M5 Use real experiments to investigate elasticity, heat, sound, electricity, magnetism, light, acceleration, velocity, energy, and gravity
M6 Use real-world problem situations involving mass and weight
M7 Use real-world problem situations involving simple harmonic motion
M8 Establish ratios with and without common units
M9 Construct and interpret maps, tables, charts, and graphs as they relate to real-world mathematics
M10 Understand and solve rate-change problems
M11 Understand and solve right triangle relationships as they relate to measurement, specifically to Pythagorean theorem
M12 Graph and interpret ordered pairs
M13 Compute total sales from a variety of items
M14 Comprehend and compute rates of growth or decay
M15 Comprehend, compute, and interpret real problems involving annuities

Subunit: Measurement (continued)
Competencies:

M16 Develop an ability to identify real problems and provide possible solutions
M17 Express and apply different types of measurement scales
M18 Identify area and volume

Subunit: Estimation and Mental Computation
Competencies:

E1 Use estimation to eliminate choices in multiple-choice tests
E2 Use estimation to determine reasonableness of problem situations in a wide variety of applications
E3 Estimate shape of graphs of various functions and algebraic expressions
E4 Use mental computation when computer and calculator are inappropriate

Subunit: Data Analysis and Probability
Competencies:

D1 Organize data into tables, charts, and graphs
D2 Understand and apply measures of central tendency, variability, and correlation
D3 Use curve fitting to predict from data
D4 Use experimental or theoretical probability, as appropriate, to represent and solve problems involving uncertainty
D5 Use computer simulations and random number generators to estimate probabilities
D6 Test hypotheses using appropriate statistics
D7 Read, interpret, and use tables, charts, and graphs to identify patterns, note trends, draw conclusions, and make predictions
D8 Identify probabilities of events involving unbiased objects
D9 Use sampling and recognize its role in statistical claims
D10 Design a statistical experiment to study problem, conduct experiment, and interpret and communicate outcomes
D11 Describe normal curve in general terms and use its properties
D12 Create and interpret discrete probability distributions
D13 Understand concept of random variable
D14 Apply concept of random variable to generate and interpret probability distributions, including binomial, uniform, and chi square

Subunit: Algebra
Competencies:

A1 Describe problem situations by using and relating numerical, symbolic, and graphical representations
A2 Use language and notation of functions in symbolic and graphing settings
A3 Recognize and use equivalent zeros of a function, roots and the solution of an equation in terms of graphical and symbolic representations
A4 Describe and use logic of equivalence in working with equations, inequalities, and functions
A5 Develop graphical techniques of solution for problem situations involving functions
A6 Explore and describe characterizing features of functions
A7 Make arguments and proofs in algebraic settings
A8 Factor difference of two squares
A9 Identify slope, midpoint, and distance
A10 Explore and combine rational functions
A11 Explore factoring techniques
A12 Solve quadratic equations by factoring and formula
A13 Set up and solve linear equations
A14 Solve systems of linear equations with two variables
A15 Describe geometric situations and phenomena using variables, equations, and functions
A16 Describe measures of central tendency, mean, median, mode, and variance algebraically and graphically
A17 Represent inequalities on number line and in coordinate plane
A18 Use coordinate arguments in making geometric proofs
A19 Symbolize transformations of figures and graphs
A20 Explore geometric basis for functions of trigonometry
A21 Graph linear functions
A22 Develop and use vectors to represent direction and magnitude including operations
A23 Use polar and parametric equations to describe, graph, and solve problem situations
A24 Represent sequences and series as functions both algebraically and graphically
A25 Explore recursive functions and procedures using spreadsheets, other computer utilities, and appropriate notions
A26 Describe and solve algebraic situations with matrices
A27 Describe and use inverse relationship between functions including exponential and logarithmic

Subunit: Algebra (continued)
Competencies:

A28 Analyze and describe errors and error sources that can be made when using computers and calculators to solve problems
A29 Decide whether problem situation is best solved using computer, calculator, paper and pencil, or mental arithmetic/estimation techniques
A30 Explore relationships between complex numbers and vectors
A31 Make arguments concerning limits, convergence and divergence in context involving sequences, series, and other types of functions
A32 Represent transformations in plane with matrices
A33 Contrast and compare algebra's of rational, real, and complex numbers with characteristics of a matrix algebra system
A34 Construct polynomial approximations of a function over specified intervals of convergence
A35 Examine complex numbers as zeros of functions
A36 Translate verbal statements into symbolic language
A37 Simplify algebraic expressions
A38 Use laws and exponents (including scientific notation)
A39 Expand and extend idea of vectors and linear algebra to higher dimensional situations
A40 Use the idea of independent basis elements for a vector space and associated fundamental concepts of finite dimensional linear algebra
A41 Develop and communicate arguments about limit situations
A42 Use matrices to describe and apply transformations
A43 Develop and use polar and parametric equations to represent problem situations
A44 Explore proofs by mathematical induction

Subunit: Geometry
Competencies:

G1	Create and interpret drawings of three-dimensional objects
G2	Represent problem situations with geometric models and apply properties of figures
G3	Apply Pythagorean theorem
G4	Demonstrate knowledge of angles and parallel and perpendicular lines
G5	Explore inductive and deductive reasoning through applications to various subject areas
G6	Translate between synthetic and coordinate representations
G7	Identify congruent and similar figures using transformation with computer programs
G8	Deduce properties of figures using transformations and coordinates
G9	Use deductive reasoning
G10	Explore compass and straightedge constructions in context of geometric theorems
G11	Demonstrate knowledge of and ability to use proof
G12	Use variety of proof techniques (e.g., synthetic, transformational, and coordinate)
G13	Use variety of proof formats, including T-proof (i.e., two-column) and paragraph proof
G14	Explore different proof strategies
G15	Investigate different proofs of theorems
G16	Develop knowledge of an axiomatic system
G17	Apply transformations and coordinates in problem solving
G18	Represent problem situations with geometric models and apply properties of figures
G19	Deduce properties of figures using vectors
G20	Analyze properties of Euclidean transformations and relate translations to vectors
G21	Apply vectors in problem solving
G22	Develop further knowledge of axiomatic systems by investigating and comparing various geometry's

Subunit: Patterns, Relations, and Functions
Competencies:

P1 Model real-world phenomena with polynomial and exponential functions
P2 Explore relationship between zeros and intercepts of functions
P3 Translate among tables, algebraic expressions, and graphs of functions
P4 Use graphing calculator or computer to generate graph of a function
P5 Explore relationship between a linear function and its inverse
P6 Describe and use characteristics of polynomial functions in problem-solving situations
P7 Explore conic sections and graph using graphing calculator or computer
P8 Apply trigonometric functions to problem situations involving triangles
P9 Discover relationships between algebraic description, kind, and properties of conic
P10 Explore periodic real-world phenomena using sine and cosine functions
P11 Analyze effects of parameter changes on graphs
P12 Use graphing calculator or computer to graph functions
P13 Develop an knowledge of rational and transcendental functions
P14 Understand connections between trigonometric and circular functions
P15 Use circular functions to model periodic real-world functions
P16 Solve trigonometric equations and verify trigonometric identities
P17 Understand connections between trigonometric, exponential, and logarithmic functions and polar coordinates, complex numbers, and series
P18 Model real-world phenomena with a variety of functions
P19 Graph using polar coordinates
P20 Explore graphs in three dimensions
P21 Explore functions of several variables
P22 Explore recursive functions using spreadsheets and/or programming languages

Unit: Science Literacy

NOTE: This content was extracted from the 9-12 cluster of Ohio's Draft Model Science Program. Due to statewide initiatives other than Tech Prep, this literacy unit was not altered to meet competency-based criteria. Each literacy unit forms a critical link between academic teachers and members of business, industry, and labor. [See "The TCP Process" for more information.]

Subunit: Scientific Inquiry
Competencies:

Q1 Check the appropriateness and accuracy of measures and computations using various strategies (e.g., estimations, unit analysis, determination of significant figures)
Q2 Use ratios, proportions, and probabilities in appropriate problem situations
Q3 Translate information from and represent information in various forms with equal ease (e.g., tables, charts, graphs, diagrams, geometric figures)
Q4 Use existing algebraic formulas and create new ones in appropriate problem-solving situations
Q5 Estimate and justify probabilities of outcomes of familiar situations based on experimentation and other strategies
Q6 Invent apparatus and mechanical tools needed to perform unique tasks in various situations
Q7 Identify, compare, and contrast different modes of inquiry, habits of mind, and attitudes and dispositions
Q8 Design investigations that are safe and ethical (i.e., obtain consent and inform others of potential outcomes, risks and benefits, and show evidence of concern for human health and safety, concern for non-human species)
Q9 Make and read scale drawings, maps, models, and other representations to aid planning and understanding
Q10 Seek elaboration and justification of data and ideas, and reflect on alternative interpretations of the information
Q11 Use appropriate units for counts and measures
Q12 Create and use databases (electronic and other) to collect, organize, and verify data and observations
Q13 Design and conduct investigations with multiple variables
Q14 Communicate the results of investigations clearly in a variety of situations

Subunit: Scientific Inquiry (continued)
Competencies:

Q15 Examine relationships in nature, offer alternative explanations for the observations, and collect evidence that can be used to help judge among explanations
Q16 Trace the development (e.g., history, controversy, and ramifications) of various theories, focusing on supporting evidence and modification with new evidence
Q17 Select, invent, and use tools, including analog and digital instruments, to make and record direct measurements
Q18 Observe and document events and characteristics of complex systems
Q19 Explain the influence of perspective (e.g., spatial, temporal, and social) on observation and subsequent interpretations
Q20 Create multiple representations of the same data using a variety of symbols, descriptive languages, mathematical concepts, and graphic techniques
Q21 Generate testable hypotheses for observations of complex systems and interactions
Q22 Document potentially hazardous conditions and associated risks in selected homes and public areas
Q23 Participate in public debates, relying on documented and verified data to construct and represent a position on scientific issues
Q24 Construct and test models of physical, biological, social, and geological systems
Q25 Read, verify, debate, and, where necessary, refute research published in popular or technical journals of science (e.g., *Discover*, *Omni*, *Popular Mechanics*)
Q26 Explore discrepant events and develop and test explanations of what was observed
Q27 Conduct theory-based research using surveys, observational instruments, and other methods
Q28 Modify personal opinions, interpretations, explanations, and conclusions based on new information
Q29 Analyze error and develop explanations in various domains
Q30 Formulate taxonomic schemes based upon multivariate models that help to explain similarities and differences in form, distribution, behavior, survival, and origin of objects and organisms
Q31 Demonstrate various logical connections between related concepts (e.g., entropy, conservation of energy)
Q32 Account for discrepancies between theories and observations
Q33 Analyze the changes within a system when inputs, outputs, and interactions are altered

Subunit: Scientific Inquiry (continued)
Competencies:

Q34 Create, standardize, and document procedures
Q35 Determine the sources of significant disparities between the predicted and recorded results and change research procedures to minimize disparities
Q36 Research, locate, and propose applications for abstract patterns (e.g., fractals, Fibonacci sequences, string theory, orbitals)
Q37 Recognize and utilize classification systems for particles, elements, compounds, phenomena, organisms, and others for exploring and predicting properties and behaviors
Q38 Suggest and defend alternative experimental designs and data explanations (e.g., sampling, controls, safeguards)
Q39 Recognize and communicate differences between questions that can be investigated in a scientific way and those that rely on other ways of knowing
Q40 Draw conclusions based on the relationships among data analysis, experimental design, and possible models and theories
Q41 Suggest new questions as a result of reflection on and discussions about their own scientific investigations
Q42 Investigate, assess, and comment on strengths and weakness of the descriptive and predictive powers of science
Q43 Create new information from representations of data in a variety of forms (e.g., symbols, descriptive languages, graphic formats) utilizing a variety of techniques (e.g., interpolations, extrapolations, linear regressions, central tendencies, correlation's)

Subunit: Scientific Knowledge
Competencies:

K1 Investigate various types of dynamic equilibrium (e.g., biological, geological, mechanical, chemical)
K2 Investigate the relationship between the rates of energy exchange and the relative energy level of components with systems (e.g., tropic levels of ecosystems, osmosis, rate of heating and cooling, storms)
K3 Investigate patterns in the natural world (e.g., heredity, crystalline structures, population and resource distributions, diffraction, dispersion, polarization)
K4 Investigate models and theories that help to explain the interactions of components in systems (e.g., conservation of mass, energy, and momentum; food webs; natural selection; entropy; plate tectonics; chaos; relativity; social-psychology)
K5 Investigate degrees of kinship among organisms and groups of organisms
K6 Investigate the limits of the definition of life, and investigate organisms and physical systems that exist at or near these limits (e.g. viruses, quarks, black holes)
K7 Investigate estimates and measurements of a wide range of distances and rates of change
K8 Investigate the historical development of theories of change over time (e.g., natural selection, continental drift, the big bang, geologic change)
K9 Investigate physical and chemical changes in living and non-living systems (e.g., photosynthesis, weathering processes, glaciation, thermal effects of materials, energy cells)
K10 Investigate simulations of nuclear change (e.g., radioactivity, half life, carbon dating)
K11 Investigate conservation principles associated with physical, chemical, and nuclear changes
K12 Formulate descriptions of the impacts of various forms of mechanical and electromagnetic waves on various organisms on each other over time
K13 Formulate models and hypotheses for patterns in the natural world (e.g., earth structures, transportation systems, migrations, communications, constellations)
K14 Formulate explanations for the influences of objects and organisms on each other over time
K15 Formulate and interpret explanations for change phenomena (e.g., mass extinction's, stellar evolution, punctuated equilibrium, molecular synthesis)

Subunit: Scientific Knowledge (continued)
Competencies:

K16 Formulate and interpret explanations for the magnitudes of diversity at different periods of geologic time (e.g., mutation, global cataclysms, continental drift, competition, mass extinction's)

K17 Formulate interpretations of the structure, function, and diversity in a variety of organisms and physical systems (e.g., DNA and RNA variants, nucleons, interaction particles)

K18 Formulate understandings of geologic time (e.g., millennia, periods, epochs)

K19 Formulate an understanding of the historical development of the model of the universe

K20 Formulate explanations and representations of the production, transmission, and conservation of energy in biological and physical systems (e.g., weather, volcanism, earthquakes, electricity, magnetism, cellular respiration)

K21 Formulate models and hypotheses about patterns in the natural world (e.g., social behavior, molecular structure, energy transformation, entropy, randomness, aging, chaos, hormonal cycles)

K22 Formulate interpretations of the relationship between energy exchange and the interfaces between components within systems

K23a Formulate estimations for the range of energies within and between various phenomena (e.g., thermal, electromagnetic, thermonuclear, chemical, electrical)

K23b Formulate explanations for the historical development of descriptions of motions interactions and transformations of matter and energy (e.g., classical Newtonian mechanics, special and general relativity, chaos)

K24 Formulate models that can be used to describe fundamental molecular interactions in living and non-living systems (e.g., cell membranes, semiconductors).

K25 Formulate an understanding of the degree of relationship among organisms and objects based on molecular structure (e.g., proteins, nucleic acids)

K26 Formulate hypotheses and models that may account for observable events (e.g., electricity and magnetism, gravitation, atoms, bonding, chemical reactions, quantum effects, energy flow on biological systems, predator-prey relationships)

K27 Formulate models and hypotheses about change over time (e.g., natural selection, speciation, punctuated equilibrium, phyleytic gradualism, stellar evolution, plate tectonics, radioactive decay, quantum mechanical theory)

Subunit: Scientific Knowledge (continued)
Competencies:

K28 Formulate lists of limitations and propose refinements of standard classification systems (e.g., periodic table, IUPAC, Linnean, standard model)

K29 Formulate specific cases of limitations and possible exceptions of theories and principles regarding the interactions of moving objects and organisms (e.g., fluid flow in vessels, motion near the speed of light, Heisenberg uncertainty principle, meteorological prediction, local variation and diversity, predicting earthquakes, energy transport in cellular respiration)

K30 Formulate plans and contingencies that can be used to accommodate for changes to and stresses on systems (e.g., wildlife and habitat management, corrosion prevention, noise abatement, structure design)

K31 Formulate models of molecular, atomic, ionic, and subatomic structures and the physical and biological implications of these structures (e.g., genes, nucleons, quarks)

K32 Formulate estimates for a wide range of measurements and scales (e.g., angstroms to light years)

K33 Formulate and interpret representations of time from origin to present accounting for phenomena of scale (e.g., smoothness, punctuation's, chaos)

K34 Formulate interpretations of the historical development of various theories of possible causes of diversity among physical and biological phenomena (e.g., the works of Aristotle, Mendel, Darwin, McClintock)

K35 Formulate models and hypotheses that can be used to explain the interactions of components within technological and ecological systems

Subunit: Conditions for Learning Science
Competencies:

C1 Participate actively in dialogue about and resolution of community issues
C2 Assess information from various countries in the original language or translated form to ascertain the perspectives of many cultures
C3 Analyze the scientific ideas presented in science fiction stories and films
C4 Perform and repeat investigations to verify data, determine regularity, and reduce the impact of experimental error
C5 Present the results of investigations in a variety of forums
C6 Contribute to the decisions regarding topics for investigation
C7 Use various creative means to communicate interpretations of scientific ideas, concepts, phenomena, and events
C8 Consider the scientific thinking and language of others
C9 Individually and collaboratively produce clearly written representations of investigative results
C10 Fulfill responsibilities as part of a research group
C11 Select and utilize resources by various criteria (e.g., efficiency, effectiveness, health, safety) that are appropriate to the investigations being conducted by groups
C12 Present persuasive argument based on the scientific aspects of controversial issues
C13 Collect, store, retrieve, and manipulate information with available t technologies alleges that may range from hand processes up through computer applications
C14 Investigate social issues with a scientific perspective (e.g., human rights, wellness, economics, futurism, environmental ethics)
C15 Keep journals of observations and inferences made over an extended period of time and reflecting upon the impact of these recorded ideas on their thinking and actions
C16 Examine the intellect, perspectives, and ethics of notable scientists
C17 Collect and analyze observations made over extended periods of time and compare these to scientific theories
C18 Create presentations of scientific understandings using diverse modes of expressions
C19 Conduct formal scientific debates in the classroom
C20 Wonder about the likelihood of events that may occur by chance or coincidence
C21 Plan and conduct field trips and experiences for small and large groups
C22 Analyze the historical context which leads to and has lead to scientific t theories

Subunit: Conditions for Learning Science (continued)
Competencies:

C23 Seek information on topics of personal scientific interest from a variety of sources
C24 Conduct learner-developed investigations independently and collaboratively over periods of week and months
C25 Listen attentively and critically to presentations of scientific information made by others
C26 Conduct analyses of propaganda related to scientific issues
C27 Perform investigations that require observations over varying periods of time
C28 Experience scientific concepts as interpreted by other cultures through multimedia and local and global specialists
C29 Access appropriate technology to perform complicated, time-consuming tasks
C30 Relate historical accounts of science to the cultural context in which they were written
C31 Work as a contributing member of a collaborative research group
C32 Examine the influences of social and political structures and realities that contribute to inquiry about scientific issues
C33 Use technology (e.g., desktop publishing, teleconferencing, networking) to communicate scientific ideas
C34 Explore and analyze a variety of perspectives on science (e.g., works by men and women of many racial, ethnic, and cultural groups)
C35 Lead groups of learners of various ages in designing, planning, and conducting science activities
C36 Respect the scientific thinking of others and self
C37 Recognize and contrast different epistemologies
C38 Develop possible courses of action in response to scientific issues of local and global concern
C39 Determine the validity of research conclusions in relation to the design, performance, and results
C40 Develop multimedia presentations of group and individual research projects and investigations appropriate for a variety of audiences and forums
C41 Produce interesting and scientifically correct stories and present them using various modes of expression
C42 Reflect on the ideas and content found in their own journal records
C43 Examine ambiguous results and formulate explanations
C44 Recognize and synthesize the contributions to scientific thought of individuals from many cultures

Subunit: Conditions for Learning Science (continued)
Competencies:

C45 Construct models and simulations of the component structures and functions of living and non-living entities
C46 Lead multi-age groups in the examination of and planned resolution for scientific issues
C47 Recognize and choose members of research teams based upon the merit of their ideas and skills
C48 Construct a portfolio of products, documentation, and self-evaluations of his/her own abilities, skills, and experiences
C49 Synthesize scientific information from a variety of sources
C50 Evaluate and prioritize scientific issues based upon risk-benefit analyses
C51 Refining scientific skills from a variety of experiences

Subunit: Applications for Science Learning

Competencies:

A1 Answer student-determined questions by designing databases and drawing inferences from the analyses of the information in these data bases

A2 Make personal behavior decisions by interpreting information that has a scientific basis

A3 Propose courses of action that will validate and demonstrate personal understandings of scientific principles

A4 Guide other learners in their understanding of the interactions of technologies and society at various periods in time

A5 Promote and carry out practices that contribute to a sustainable environment

A6 Study and propose improvements in public services and systems in their community

A7 Choose consumer materials utilizing personal and environmental risk and benefit information

A8 Make inferences and draw conclusions using databases, spreadsheets, and other technologies

A9 Do simple trouble-shooting on common electrical and mechanical systems, identifying and eliminating possible causes of malfunctions

A10 Construct devices that perform simple, repetitive actions

A11 Investigate the functionality of various geometric shapes in the natural world and the designed world (e.g., translations from spherical to plane representations cause distortions, triangular shapes contribute to rigidity and stability in structures, round shapes minimize boundary for a given capacity)

A12 Make decisions regarding personal and public health

A13 Evaluate the social and ecological risks and benefits resulting from the use of various consumer products

A14 Analyze the contributions of advances in technology through history to his/her everyday life

A15 Identify and reduce risks and threats to a sustainable environment

A16 Extend the limits of human capabilities using technological enhancements

A17 Use and recognize various propaganda techniques

A18 Solve unique problems using the results of systematic analyses

A19 Choose everyday consumer products that utilize recent innovation and pass appropriate performance criteria

A20 Refine personal career interests through investigations of the diversity of manufacturing, research, service, and invention processes

Subunit: Applications for Science Learning (continued)
Competencies:

A21 Predict and investigate the working of toys and tools while controlling and manipulating variables (e.g., friction, gravity, forces)

A22 Write, follow, modify, and extend instructions (e.g., equations, algorithms, formulas, flow diagrams, illustrations)

A23 Create products, make inferences, and draw conclusions using databases, spreadsheets, and other technologies

A24 Predict various scenarios and propose solutions to community issues using scientific information (e.g., actuarial tables, census data, topographic maps, incidence data, climatic data)

A25 Use scientific evidence to consider options and formulate positions about the health and safety of others and him/herself

A26 Search for, use, create, and store objects and information using various strategies and methods of organization and access

A27 Research and write environmental impact statements of his/her own design

A28 Compare school-based science perspectives with those gained through cutting-edge technological applications

A29 Design management plans for natural and human-altered environments (e.g., woodlots, patios, lots, lawns, farmlands, forests)

A30 Refine personal career interests

A31 Promote public awareness of the interaction of technology with social i issues

A32 Advocate and propose courses of action for local and global scientific issues using global networks

A33 Use appropriate technologies to prepare and present the findings of investigations incorporating tables, graphs, diagrams, and text

A34 Make informed consumer choices by evaluating and prioritizing information, evidence, and strategies

A35 Develop an informed point-of-view that allows for validation or refutation of the scientific statements and claims of advocated before pursuing courses of action (e.g., contributing support, signing petitions, casting votes)

A36 Differentiate between observations and inferences in the exploration of evidence related to personal, scientific, and community issues

A37 Develop and write environmental impact and safety and hygiene management plans

A38 Use technology to collect, analyze, and communicate information (e.g., electronic networks, desktop publishing, remote sensing, graphing calculators, satellite telemetry, and others)

A39 Design, construct, and market inventions

Unit: Technology Literacy

NOTE: Over 500 Ohio business, industry, and labor representatives examined, altered, and then verified the content for this unit during the TCP Process. The original content was extracted from the Report of the Task Force on Technology Competence—Learner Goals for All Minnesotans, published by the Minnesota State Council on Vocational Technical Education. The Technology Literacy unit forms a critical link between all teachers and stresses the importance of technological impact on teaching and learning. [See "The TCP Process" for more information.]

Competencies:

T1 Demonstrate a systems view of technology based on the interdependence of social, political, economic, and ecological systems
T2 Assess the career, family, and personal development implications of technological change
T3 Demonstrate continuous learning via technology
T4 Demonstrate global appreciation for technology's potential effects on cultures, geographic areas, and the environment
T5 Apply historical perspective on technology to the development and use of new technologies
T6 Apply diverse technologies to store, access, process, create, and communicate information needed to solve problems
T7 Apply legal principles and ethical conduct to the use of technology
T8 Demonstrate competency in mathematics, science, social sciences, communication, and computer skills through the analysis, design, and evaluation of technological systems
T9 Analyze the potential of alternative technological systems to solve problems and/or to extend human capabilities
T10 Use a variety of tools, materials, and equipment in solving problems and extending human capabilities
T11 Assess risks and benefits of technological developments from an ecological, economic, social, and political perspective
T12 Value human diversity as part of a team in suggesting, designing, and testing solutions to technological problems

Unit: Employability Skills

Competency: Develop a career plan

Competency Builders:

Identify current interests and aptitudes
Identify common barriers to employment
Describe strategies to overcome employment barriers
Locate resources for finding employment
Research job trends
Identify career options
Identify advantages and disadvantages of career options (in addition to other than monetary)
Identify job requirements
Investigate education/training opportunities
Evaluate personal strengths and weaknesses

Competency: Prepare for employment

Competency Builders:

Identify traditional and non-traditional employment sources
Identify present and future employment opportunities (by geographic location)
Research job opportunities, including non-traditional careers
Compare salary ranges and benefit packages
Compile occupational profile
Identify rights and responsibilities of equal employment opportunity laws
Design resume and cover letter
Target resume
Secure references
Investigate generic and specific employment tests (e.g., civil service exam; drug screening)
Use follow-up techniques to enhance employment potential
Demonstrate legible written communication skills using correct grammar, spelling, punctuation, and concise wording
Describe methods for handling illegal questions on job application forms and during interviews
Write letter of application
Research prospective employer and services performed
Explain critical importance of personal appearance, hygiene, and demeanor
Interpret job description
Demonstrate appropriate interview question and answer techniques
Demonstrate methods for handling difficult interview questions
Evaluate job offers
Write letter of acceptance
Write letter of declination
Demonstrate good listening skills
Ask for the job tactfully
Participate in extracurricular activities (e.g., student government, community projects,)

Competency: Evaluate the importance of self-esteem as an employability skill

Competency Builders:

Identify factors that affect self-esteem
Compare effects of low self-esteem and high self-esteem
Identify strategies to promote positive self-esteem

Competency: Demonstrate job retention skills

Competency Builders:

Identify employer expectations regarding job performance, work habits, attitudes, personal appearance, and hygiene
Exhibit appropriate work habits and attitude
Demonstrate ability to set priorities
Identify behaviors to establish successful working relationships
Identify alternatives for dealing with harassment, bias, and discrimination based on race, color, national origin, sex, religion, handicap, or age
Identify opportunities for advancement
List reasons for termination
List consequences of being absent frequently from job
List consequences of frequently arriving late for work
Demonstrate interpersonal relations skills (i.e., verbal and written)
Demonstrate negotiation skills
Demonstrate teamwork
Follow chain-of-command
Exhibit appropriate job dedication

Competency: Demonstrate knowledge of work ethic

Competency Builders:

Define work ethic
Identify factors that influence work ethic
Differentiate law and ethics
Describe how personal values are reflected in work ethic
Describe how interactions in the workplace affect personal work ethic
Describe how life changes affect personal work ethic

Competency: Exhibit appropriate work ethic

Competency Builders:

Use time-management techniques
Avoid personal activity during work hours
Attend work as scheduled
Adhere to company and/or governmental policies, procedures, rules, and regulations
Exercise confidentiality
Demonstrate appropriate human relations skills
Adhere to rules of conduct
Accept constructive criticism
Offer constructive criticism
Take pride in work
Resolve conflict
Manage stress
Avoid sexual connotations and harassment
Adjust to changes in the workplace
Demonstrate punctuality
Assume responsibility for personal decisions and actions
Take responsibility for assignments
Follow chain-of-command

Competency: Apply decision-making techniques

Competency Builders:

Identify decision to be made
Identify ownership of decision to be made
Identify possible alternatives and their consequences
Make decisions based on facts, legality, ethics, goals, and/or culture
Apply time factor(s)
Present decision to be implemented
Evaluate decision made
Take responsibility for decision

Competency: Apply problem-solving techniques

Competency Builders:

Identify problem
Select appropriate problem solving tools/techniques
Identify root problem cause(s)
Track root problem cause(s)
Identify possible solutions and their consequences (e.g., long term, short term, crisis)
Use resources to explore possible solutions to problem
Contrast advantages and disadvantages of each solution
Identify appropriate action
Evaluate results
Identify post-preventive action

Competency: Exhibit characteristics for job advancement

Competency Builders:

Display positive attitude
Demonstrate knowledge of position
Perform quality work
Adapt to changing situations and technology
Demonstrate capability/responsibility for different positions
Identify characteristics of effective leaders
Identify opportunities for leadership in work place/community
Demonstrate initiative to affect change in workplace
Participate in continuing education/training program
Responds appropriately to criticism from employer, supervisor, or other employees
Exhibit awareness of corporate culture
Prepare for job setbacks
Exhibit continual growth based on performance evaluation
Set realistic goals

Unit: Professionalism

Competency: Project professional image

Competency Builders:

Define professionalism
Exhibit professional appearance
Exhibit professional manners
Project professional attitude
Identify individuals' vital role in organization
Exhibit proper etiquette in professionally-related situations

Competency: Achieve individual and professional goals

Competency Builders:

Set flexible, realistic, and measurable goals
Identify potential barriers to achieving goals
Identify strategies for addressing barriers to goal achievement
Breakdown long-term goals into short-term goals
Prioritize goals
Commit to goals
Adjust goals
Obtain support for goals
Reward goal achievement

Competency: Manage personal finances

Competency Builders:

Explain need for personal management records
Balance checkbook
Identify tax obligations
Analyze how credit affects financial security
Compare types and methods of investments
Compare types and methods of borrowing
Compare types and methods of insurance
Compare types of retirement options/plans
Identify discriminatory vs. non-discriminatory expenditures

Competency: Support community well-being

Competency Builders:

Identify environmental, educational, and social issues
Participate in social and/or community activities

Competency: Achieve organizational goals

Competency Builders:

Evaluate personal goals in relation to organizational goals
Monitor progress by evaluating feedback
List responsibilities in relation to organization goals
Accomplish assigned tasks
Exercise responsibility in relation to organizational goals
Set appropriate personal performance standards
Communicate goals with supervisor and peers
Demonstrate knowledge of products and services
Promote organizational image and mission

Competency: Demonstrate positive relations in the workplace

Competency Builders:

Identify personality types of self and other
Identify various management styles
Support employer expectations
Support employer decisions
Accept constructive criticism
Give constructive feedback
Adapt to changes in workplace
List factors to consider before resigning
Write letter of resignation

Competency: Manage stressful situations

Competency Builders:

Accept stress as part of daily life
Identify personal and professional factors contributing to stress
Describe physical and emotional responses to stress
Evaluate positive and negative effects of stress on productivity
Identify strategies for reducing stress
Implement strategies to manage stress
Create strategies for developing and maintaining support systems

Competency: Analyze effects of family on work and work on family

Competency Builders:

Identify how family values, goals, and priorities are reflected in work place
Identify responsibilities and rewards associated with paid and non-paid work
Identify responsibilities and rewards associated with families
Explain how family responsibilities can conflict with work
Explain how work can conflict with family responsibilities
Explain how work-related stress can affect families
Explain how family-related stress can affect work
Identify family support systems and resources
Identify work-related support systems and resources
Communicate with family regarding work

Competency: Apply lifelong learning skills

Competency Builders:

Define lifelong learning
Identify factors that cause need for lifelong learning
Analyze effects of change
Identify reasons why goals change
Describe importance of flexibility and adaptability
Evaluate need for continuing education/training

Competency: Manage professional development

Competency Builders:

Identify career opportunities
Modify career plan
Participate in continuing education/training opportunities
Document continuing education/training
Read profession-related manuals, technical journals, and periodicals
Attend meetings, workshops, seminars, conferences, and demonstrations
Participate in professional organizations
Build personal/professional mentor relationship
Build personal/professional support system
Build professional network
Strengthen communication skills
Strengthen leadership skills
Strengthen management skills

Unit: Teamwork

Competency: Demonstrate knowledge of teamwork

Competency Builders:

Define empowerment
Differentiate work groups and teams
Identify conditions essential to teamwork (e.g., brainstorming)
Explain influence of culture (e.g., corporate, community) on teamwork
Identify appropriate situations for using teams
Define team structures (e.g., cross functional, quality improvement, task force, quality circles)
Identify team building concepts
Describe characteristics and dynamics of teams
Identify characteristics of effective team leaders and members
Identify responsibilities of a valuable team member
Identify methods of involving each member of a team
Explain how individuals from various backgrounds contribute to work-related situations (e.g., technical training, cultural heritage)
Explain the purpose of facilitators
Define consensus
Define reward/recognition system

Competency: Demonstrate teamwork

Competency Builders:

Identify purpose of team and intended goal (include time frames)
Structure team around purpose
Define responsibilities of team members
Contribute to efficiency and success of team
Work toward individual and team milestones
Analyze results of team project
Facilitate a team meeting
Assist team member(s) with problem
Monitor time frame
Stress continuous improvement
Accept failure as part of learning

Competency: Use teamwork to solve problems

Competency Builders:

Identify appropriate situations for using teams
Use problem-solving process in a team setting
Identify quality management processes/techniques
Identify quality assurance processes/techniques
Prepare presentation

Competency: Conduct team meetings

Competency Builders:

Plan agenda
Schedule meeting and location
Invite appropriate personnel
Solicit outside speakers as needed
Assign someone to take minutes
Facilitate introductions
Invite questions and comments and group participation
Focus team on agenda items
Assign appropriate action, time frame and accountability to tasks
Monitor time
Close meeting on time
Publish minutes in timely manner
Set ground rules
Avoid placing individual agendas above the group's agenda

Unit: Quality Assurance

Competency: Demonstrate knowledge of quality assurance

Competency Builders:

Explain the historical evolution of quality assurance (e.g., Deming, ISO 9000)
Explain changes brought about by quality leaders in the world
Explain the ISO 9000 process
Define quality terms
Define quality functions
Identify features of quality planning
Describe control devices used in functional areas (e.g., SPC, equipment)
Explain the relationship among organizational structures, policies, procedures, and quality assurance
Explain importance of internal and external customers
Identify internal and external customers
Describe successful efforts by industry to improve quality and/or reduce costs
Differentiate prevention and detection
Differentiate variable and attribute data
Identify types of coontrol charts
Explain how statistical techniques are tools used to control quality (e.g., SPC, DOE, CR)

Competency: **Demonstrate knowledge of quality cost implications**

Competency Builders:

Identify cost/quality objectives
Classify costs (i.e., direct and indirect, fixed and variable, methods and standards)
Classify quality costs (i.e., prevention, evaluation, pre-delivery failure, post-delivery failure)
Define produce liability
Interpret quality cost reports
Explain consumerism and liability prevention
Define safety terms of product
Identify safety responsibility within organization
Define contracts and torts
Differentiate express and implied warranty
Differentiate warranty and product liability
Explain how warranties are part of contract law
List questions that would need answering in liability claim

Competency: **Demonstrate knowledge of engineering a quality product**

Competency Builders:

Associate customer satisfaction with product characteristics (e.g., usefulness, price, operation, life, reliability, safety, cost of operation)
Define manufacturability
Identify steps in product design (e.g., brainstorming, thumbnail sketches, rendering)
Define reliability factors (e.g., cost, human, producibility)
Identify ways reliability is achieved (e.g., maintainability, good design, design simplification, design redundancy)
Explain the relationship of maintainability to reliability
Define failure
Explain the role of testing and reliability
Define value engineering
Define quality objectives
Identify cost components as they relate to quality objectives
Classify quality costs (i.e. preventive, evaluation, pre-delivery failures, post delivery failures)
Describe predictive maintenance

Competency: Explain importance of interdepartmental relationships to quality assurance

Competency Builders:

Explain need for everyone's commitment in assuring quality
Explain phrase "Everyone is a customer/supplier"
Define quality improvement team models
Explain the importance of top management's support of quality
Explain project selection
Explain project implementation
Explain project evaluation
Explain continuing improvement
Describe future trend of experiment design
Describe future trend of predictive maintenance

Competency: Manipulate quality cost data

Competency Builders:

Develop quality cost data
Translate cost reports
Graph quality cost data (e.g., pareto)

Competency: Manipulate cost control data

Competency Builders:

Develop cost control data
Analyze cost control reports
Provide cost control data
Provide advice on "Make or Buy" decisions (including economical lot size decisions)

Competency: Demonstrate knowledge of basic statistics

Competency Builders:

Describe data collection methods
Collect data
Organize data by flow chart
Interpret data by cause and effect diagrams
Define nominal, ordinal, interval, and ratio data
Define mean, median, and mode
Explain significance of standard deviation
Explain normal distribution

Competency: Demonstrate knowledge of scattergrams

Competency Builders:

Construct scattergram
Interpret for positive, negative, or no correlation between X and Y variables
Test for significance between one and five percent
Explain regression analysis

Competency: Demonstrate knowledge of probability theory

Competency Builders:

Define classical probability
Define empirical probability
Calculate probability for outcomes

Competency: Demonstrate knowledge of precontrol

Competency Builders:

Explain uses of precontrol
Calculate precontrol limits
Explain significance of the limits
Plot values on a precontrol chart
Explain "out-of-control" situation
Make decisions on green, yellow and red conditions

Competency: Demonstrate knowledge of process capability

Competency Builders:

Use X, R, USL, and LSL to determine process capability (upper and lower specification limits)
Calculate estimated process standard deviation
Plot right hand and left hand tail of process variation
Compute Z value for percent of probable defect for process
Calculate C_{PK} values that describe process capability
Describe skewed distributions
List probable causes of skewed distribution

Competency: Use quality control charts

Competency Builders:

Identify operational definitions for attribute criteria
Interpret histogram
Interpret scattergrams
Interpret NP chart
Interpret P chart
Interpret flowchart
Interpret cause-and-effect diagram
Construct P (percentage defective) chart for attributes
Plot control limits of P chart and data points
Check chart for out-of-control conditions
Construct an NP (number defective) chart with control limits and data
Construct C (count of defects) and U (number of defects per unit) charts
Check data on C and U charts
Construct flowchart
Construct cause-and-effect chart

Competency: Interpret $\overline{X}$ and R charts

Competency Builders:

Plot percentages for normal distribution
Test distribution for normality
Explain difference between common cause and special cause
Define an "in-control" process
Explain significance of an out-of-control point on $\overline{X}$ or R chart
Identify patterns and trends on control chart
Identify run up and run down
Test for middle third on control chart
Explain significance of middle third on control chart
Explain Rule of Sevens

Competency: Construct $\overline{X}$ and R charts

Competency Builders:

Arrange data into statistical sub-groups
Explain importance of random sampling
Compute $\overline{X}$ (i.e., average of values) and R (i.e., range of values in subgroup) within sample
Plot in $\overline{X}$ and R on chart
Construct control chart with $\overline{\overline{X}}$ (grand average) and R (average range) calculated
Calculate upper and lower control limits for $\overline{X}$-chart
Calculate upper and lower control limits for R-chart

Competency: Conduct process improvement studies

Competency Builders:

Analyze production methods and processes applying statistical process improvement techniques (e.g., SPC, C_{PK})
Identify appropriate statistical techniques for study (e.g., T-tests, F-test, capability, DOEX)
Identify major steps in conducting a study
Define "report" for a study (e.g., goal, objective, study conduct, results, conclusions, discussions)
Integrate results into the total system

Competency: Demonstrate knowledge of JIT

Competency Builders:

Define just-in-time concept (JIT)
Describe various production methodologies (e.g., standard cycle times, routings, standard quantities, multiple-machine tending)
Describe types of inventory control (e.g., Kanban)
Describe importance of flexibility
Differentiate product layout, process layout, fixed position layout, and cellular layout
Differentiate straight-line, U-shaped, S-shaped, convoluted and comb patterns
Describe advantages/disadvantages of layout and patterns
Explain importance of product protection, identification and storage
List methods of identifying products (e.g., labels, bar codes, radio frequency systems and magnetic strip systems)
Describe manual methods of storage and retrieval
Describe automated storage and retrieval systems (ASRS)
Describe automated guided vehicle moving systems (AGVS)

Competency: Apply JIT

Comptency Builders:

Maintain system for physical handling and movement of material in-process and in-storage
Monitor system of physical handling and movement of material in-process and in-storage
Maintain system for physical handling and movement of finished products
Monitor system of physical handling and movement of finished products
Write requests for deviation from specifications
Implement quality control and inspection standards and procedures
Write engineering change notices and rejection reports
Monitor reports of discrepancy or rejects during production process
Conduct quality tests under different environmental conditions

Competency: Demonstrate knowledge of inspection

Competency Builders:

Explain purpose of inspection
Describe scope of inspection
Explain purpose of incoming, ongoing, and final inspections
Explain early detection inspection
Explain how statistical process control (SPC) aids inspection
Define types of nonconformance
Define degrees of nonconformance
Define corrective action
Describe when to 100% inspect
Describe when to sample inspect
Describe methods of testing for material properties (e.g., harness, strength, chemical makeup, flaws, errors in tooling or setup)
Define rework, salvage, and scrap
Describe ethical decisions an inspector may make
Identify purposes of computer-automated inspection
Explain advantages and limitations of automated inspection
Explain disposition of non-conforming material
Explain basic foolproofing concept to build inspection into process (i.e., poka-yoke)
Use checksheets to organize and record inspection results

Competency: Inspect machinery, materials, and products

Competency Builders:

Identify critical material characteristics from specification(s) or drawing(s)
Perform capability studies for machinery and materials acceptance
Identify appropriate acceptance sampling plan
Conduct incoming materials inspection using sampling plan criteria
Identify critical in-process characteristics from specification(s) or drawing(s)
Demonstrate basic metrology skills
Conduct in-process inspection
Identify appropriate inspection reports and follow-up
Gauge R and R (reproducibility and repeatability)
Apply geometric tolerancing
Explain C = O (zro) acceptance plan
Interpret instructions in a control plan

Competency: **Demonstrate knowledge of nondestructive testing**

Competency Builders:

Describe purpose of nondestructive testing
Identify anomalies
Define defects and discontinuities
Identify factors contributing to defects and discontinuities
Describe ultrasonic testing
Describe advantages and limitations of ultrasonic testing
Describe industrial radiography
Compare use of wet and dry particles in magnetic particle inspection
Explain advantages and limitations of penetrant inspection
Describe microwave testing
Describe holographic inspection
Explain choice of most suitable nondestructive test method
Describe eddy-current testing

Unit: Technical Recording and Reporting

Competency: **Demonstrate proficiency in technical recording**

Competency Builders:

Describe various documentation procedures
Interpret specifications or drawings
Observe process
Ask open-ended questions
Record process (e.g., flowchart, step-by-step)
Identify parameters
Record accurate, truthful data
Maintain test logs
Compile cumulative reference notebook/record
Measure appropriate parameters
Draft preventive maintenance and calibration procedures

Competency: **Demonstrate proficiency in technical reporting**

Competency Builders:

Use data books and cross reference/technical manuals
Compose technical memoranda
Identify type of report or format needed
Use appropriate format
Compile relevant data
Design charts and graphs
Analyze data
Draw conclusions
Explain analytical methods used
Outline reports
Write reports
Present reports

Unit: Computer Literacy

Competency: Describe personal computer operations

Competency Builders:

Explain how data is stored in main computer memory
Explain how computer system executes program instruction
Explain computer storage capacity
Explain how data is represented
Describe data storage techniques
Identify types of memory

Competency: Explain information processing cycle

Competency Builders:

Define operating systems (e.g., DOS, OS/2, UNIX, MAC)
Describe computer languages and their use
Describe computer languages and their use
Describe computer languages and their use
Describe difference between data files and program files
Explain PC layout
Explain PC network layout
Explain mini/mainframe network layout
Differentiate hardware and software
Differentiate open from proprietary architecture

Competency: Operate computer hardware

Competency Builders:

Practice proper media handling techniques (e.g., magnetic fields, dust, liquids)
Identify hardware and its use
Use hardware (e.g., mouse, diskettes, drive, modems, touch screen, printers, digitizers, scanners, cables, protection devices)
Keyboard efficiently
Demonstrate basic care of hardware
Explain need for and application of security levels/procedures
Perform basic hardware troubleshooting
Explain hardware addressing techniques

Competency: Use software

Competency Builders:

Define software types and functions
Describe basic disk operations and care
Perform functions necessary to operate software
List advantages and disadvantages of integrated and dedicated software
Operate system software
Operate diagnostic software
Demonstrate basic proficiency in spreadsheet use
Demonstrate basic proficiency in word processing
Demonstrate basic proficiency in database use
Demonstrate basic proficiency in network use
Demonstrate basic proficiency of utility (e.g., WINDOWS, GUI)
Demonstrate basic proficiency in report writing
Demonstrate system commands
Differentiate ethical use/misuse of software
Describe bulletin boards/electronic mail
Apply security levels/procedures while handling sensitive data
Explain data compression techniques
Explain use and deletion of passwords

Unit: Workplace Safety

Competency: Apply general safety precautions

Competency Builders:

Identify local, state, and federal rules and regulations
Identify personal protective wear and equipment
Identify visual controls (e.g., monitors, read outs)
Identify auditory controls
Identify common sense housekeeping
Interpret hazardous materials notices on containers
Use personal protective wear and equipment
Apply workplace safety rules and procedures
Apply personal safety rules and procedures
Apply workplace organization (e.g., housekeeping)
Apply applicable electrical, mechanical, steam, hydraulic and (e.g., pneumatic safety rules and procedures)
Apply fire safety rules and procedures
Apply hazardous wastes rules and procedures
Apply first aid
Locate (MSDS)
Perform lockout and tagout
Recycle scrap metal, chips, shavings, coolants, solvents, trash, and waste materials
Apply common sense housekeeping
Use preventive maintenance checklists

Competency: **Demonstrate knowledge of safety and workplace hazards**

Competency Builders:

Describe corrective procedures for unsafe conditions
Identify types and potential level of workplace hazards (e.g., physical hazards, fire, chemicals, noise, ionizing radiation, ultraviolet, temperature extremes, ergonomics, biological hazards)
Identify safety materials/equipment (e.g., absorbant socks, oil dry)
Interpret Material Safety Data Sheets (MSDS)
Explain purpose(s) of OSHA and NIOSH
Explain purpose(s) of NEC and NFPA
Identify purpose of emergency evacuation routes, master switch and lockout locations, and safety color coding systems
Identify roles of industrial hygienists, safety professionals, occupational physicians, and occupational nurses
Describe methods of evaluating potential hazards (e.g., visual analysis)
Describe methods of correcting potential hazards
Describe various types of toxicity (e.g., chronic, immediate)
Identify need for reporting accidents
Explain precautions required when using toxic or flammable materials
Define confined space and related requirements
Explain how international directives relate to safety

Competency: **Explain purpose of industrial pollution control systems**

Competency Builders:

Describe types of air, water, solid waste, and noise pollution
Explain purpose of air pollution control systems
Explain purpose of water pollution control systems
Explain purpose of solid waste pollution control systems
Explain purpose of noise pollution control systems
Explain basic philosophy of "right to know" legislation
Explain purpose(s) of EPA
Identify "costs" of industrial pollution control (i.e., dollars vs. impact to environment)
Describe ethics of environmental issues

Competency: Demonstrate knowledge of ergonomics

Competency Builders:

Define ergonomics
Define risk factor
Define maximum permissible limit (MPL) and action limit (AL) for lifting
Define cumulative trauma disorder (CTD)
Identify susceptibility factors for CTD
Minimize extreme joint movement
Minimize use of excessive muscle force
Minimize repetitive tasks
Minimize mechanical stresses (e.g., sharp edges, heat, cold, hard surfaces, weights, vibration)
Minimize awkward body positions
Explain use of rest pauses
Explain need for mats and footrest for standing jobs
Explain need for appropriate working heights of chairs, stools, workbenches, equipment
Explain need for adequate lighting
Explain use of anthropometric (i.e., centering one's view of everything around man) design

Unit: Supervision

Competency: Perform supervisory functions

Competency Builders:

Define supervision
Conduct task analysis
Create organizational and/or departmental charts
Apply company policies and procedures
Maintain workplace procedures manuals
Prepare budgets
Monitor budgets
Prepare managerial reports
Analyze daily production reports
Maintain appropriate work environment
Conduct tours
Facilitate assignments
Assign work
Delegate job tasks
Monitor progress
Prepare productivity reports
Provide training for new policies
Troubleshoot workplace problems
Coordinate workplace activities
Appraise performance
Document personnel issues
Coordinate administrative duties

Competency: Coordinate training

Competency Builders:

Assess training needs
Secure training resources, materials and equipment
Train employees
Evaluate progress of trainee
Provide feedback
Solicit feedback
Receive feedback
Assess feedback

Unit: Drafting Technology

Competency: **Apply basic drafting skills**

Competency Builders:

Use drafting equipment, measuring scales, drawing media, drafting instruments and consumable materials, blueprint machine
Identify line styles, weights (alphabet of lines)
Select proper drawing scale, introduction to different types
Prepare title blocks and other drafting formats
Apply freehand and other lettering techniques
Prepare multi-view drawings
Prepare multi-view sketches
Prepare orthographic views
Prepare change control block
Describe change control block/revision block
Measure angles
Draw horizontal, vertical, angular, parallel, and perpendicular lines
Transfer an angle
Construct tangent lines (to arcs) and tangent arcs (to arcs)
Bisect angles and arcs
Bisect lines
Divide lines
Construct three-point circle
Construct regular hexagon, pentagon, and octagon
Reproduce a drawing
Prepare single-view drawings
Prepare dimension drawings
Interpret notes and dimensions to determine part
Draw arcs, circles, and conics
Transfer measurements

Competency: Apply intermediate drafting skills

Competency Builders:

Describe types of blueprints and their applications
Apply isometric, oblique and perspective sketching techniques
Prepare isometric, oblique and perspective sketches
Prepare sectional views
Prepare auxiliary views
Identify ANSI symbols
Prepare views of drilled and tapped holes, counterbores, countersinks
Apply systems drafting techniques
Identify a bill of materials
Dimension drawings using ANSIy14.5 standards
Describe purpose of auxiliary and sectional views

Competency: Apply advanced drafting skills

Competency Builders:

Interpret reports and specifications
Prepare pictorial drawings
Prepare schematics
Draw conics
Interpret basic pneumatic/hydraulic standard and symbols
Interpret various drawings (e.g., welding, casting, stamping, forging, civil, maps, pattern shop)

Competency: Interpret basic prints

Competency Builders:

Visualize object from drawing
Interpret orthographic projections
Interpret isometric views
Interpret sectional views
Interpret detail and assembly drawings
Interpret dimensions
Interpret tolerances

Competency: Interpret intermediate prints

Competency Builders:

Interpret screw thread specifications
Identify structural steel shapes
Interpret special symbols
Interpret electrical, pneumatic/hydraulic drawings
Interpret schematics

Competency: Interpret advanced prints

Competency Builders:

Interpret GD&T characteristic symbols
Interpret GD&T supplementary symbols

Competency: **Demonstrate knowledge of basic geometric dimensioning and tolerancing**

Competency Builders:

Identify geometric characteristics and symbols (i.e., flatness, straightness, roundness, cylindricity, profile of line, profile of surface, perpendicularly, angularity, parallelism, circular, runout, total indicated runout, position, concentricity, and symmetry)
Define maximum material condition
Define least material condition
Define regardless of feature size condition
Describe feature control blocks
Describe datum surfaces and targets
Define flatness (pitch)
Define straightness (yaw)
Define roundness
Define cylindrically
Define profile of line
Define profile of surface
Define perpendicularity
Define angularity
Define parallelism
Define circular runout
Define total runout
Define true position concept to determine tolerance for location of holes in mating parts

Competency: **Convert dimensions and tolerances**

Competency Builders:

Convert dimensions and tolerances from English units to metric units
Convert dimensions and tolerances from metric units to English units

Competency: Apply revision control process

Competency Builders:

Apply drawing balloons
Apply documentation (including project filing, back-up material, tracking process)
Apply change control block
Apply revision levels

Competency: Demonstrate dimensioning techniques

Competency Builders:

Construct arrowheads using various styles/disciplines
Apply symbols for surface and texture control
Add labels/notes to drawing
Interpret decimal tolerance dimensions
Dimension arcs
Dimension angles
Dimension curves
Dimension rounded-end shapes
Dimension spherical objects
Dimension cylindrical objects
Dimension cones, pyramids, and prisms
Dimension features on circular center line
Dimension theoretical point of intersection
Dimension object using rectangular coordinate system
Dimension object using polar coordinate system
Dimension object using tabular coordinate system
Dimension object using ordinate dimensioning system

Competency: Apply geometric dimensioning and tolerancing

Competency Builders:

Interpret decimal tolerance dimensions
Calculate clearance fit tolerances of mating parts
Dimension clearance fit tolerances of mating parts
Calculate interference fit tolerances of mating parts
Dimension interference fit tolerances of mating parts
Calculate tolerances to mating parts using standard fit tables
Assign tolerances to mating parts using standard fit tables
Apply positional and form tolerancing symbols
Apply symbols for true position
Apply symbols for maximum material control and regardless of feature size
Calculate effects of dimensional stack-up
Calculate transitional fit tolerances
Dimension transitional fit tolerances

Competency: Perform basic physical layouts

Competency Builders:

Use inside diameter (ID), outside diameter (OD), and hermaphrodite calipers
Layout with combination square
Layout with scriber, divider and trammel
Use surface plate
Use surface gage
Use layout fluid
Use V-blocks
Use clamps
Use angle plate
Use parallels
Use punches
Use transfer method tools
Use layout hammer
Use machinist's square
Use universal bevel protractor
Use machinist's scale

Competency: Prepare mechanical drawings

Competency Builders:

Interpret basic mechanical standards and symbols
Prepare assembly drawings
Prepare welding drawings
Prepare bearing drawings
Prepare casting drawings
Prepare forging drawings
Prepare tool drawings
Prepare molding diagrams
Prepare drawings with special processed holes
Prepare stamping drawings
Prepare numerical control drawings/instructions
Prepare installation drawings
Prepare purchase part drawings
Prepare approval drawings

Competency: Prepare advanced mechanical drawings

Competency Builders:

Resolve problems by descriptive geometry and revolutions
Use precision dimensioning to include geometric characters
Use precision measuring instruments (e.g., calipers)
Prepare fastener drawings
Prepare cam drawings
Prepare gear drawings
Prepare spring drawings
Prepare pulley and chain drive drawings

Unit: CADD Fundamentals

Competency: **Demonstrate basic use of computer operating system**

Competency Builders:

Create ASCII text files with a text editor
Explain rules for naming files and directories
Manage files
Create directories
Remove directories
Change directories
Copy files
Rename files
Erase files
Format diskettes
Label diskettes
Explain the syntax of operating system commands
Use wildcards in operating system commands

Competency: **Operate a CADD system**

Competency Builders:

Execute CADD system
Use keyboard input
Use screen and tablet menus
Use other input devices (e.g., scanner, digitizer)
Create scaled plots
Operate a pen plotter
Operate a printer-plotter (i.e., laser plotter)
Access on-line help for commands
Use file conversion
Use data transfer

Competency: Select entities for action

Competency Builders:

Add or remove entities separately
Add or remove entities using a window
Add or remove entities with a crossing-box
Select entities using a fence
Select entities by other methods (e.g., last, previous, type, all, etc.)

Competency: Create 2-D orthographic drawings

Competency Builders:

Create primitive drawing entities
Draw utilizing absolute Cartesian coordinates
Draw utilizing relative Cartesian coordinates
Draw utilizing polar coordinates
Draw using construction aides (e.g., snaps, grid, snap, etc.)
Change drawing attributes
Edit drawing entity properties (e.g., color, layer, thickness, linetype)
Construct drawing entities (e.g., offset, timer, extend, break, mirror, etc.)
Edit drawing entities (e.g., offset, trim, extend, break, mirror, etc.)
Set system variables (e.g., units, scale)
Use system variables
Create layers
Name layers
Manipulate layers
Save files
Create back-ups
Create hatches, patterns, symbols
Recall drawing templates/blocks

Competency: Annotate orthographic drawings

Competency Builders:

Create text styles
Edit text styles
Select text styles
Apply notes

Competency: Dimension orthographic drawings

Competency Builders:

Create dimensions
Edit text
Control dimension variables/models

Competency: Control display

Competency Builders:

Apply view control while drawing (e.g., zoom and pan)
Control view resolution (e.g., viewers)
Save views
Display views

Competency: Extract entity and drawing information

Competency Builders:

Measure distances
Measure areas
Identify locations
List entity characteristics (e.g., length, size, location, properties, etc.)

Unit: Intermediate CADD

Competency: Manage symbols and attributes

Competency Builders:

Create blocks and W-blocks/templates
Create nested blocks/templates
Insert blocks and drawings/templates
Redefine blocks/templates
Edit blocks/templates
Apply attributes

Competency: Create 2-D isometric drawings

Competency Builders:

Manipulate snap and grid settings
Toggle planes (e.g., left, right, top)
Create text styles for each plane
Create dimension styles
Use dimension styles
Create isometric ellipses

Competency: Use external routines

Competency Builders:

Load AutoLISP programs
Execute AutoLISP programs
Load ADS programs
Execute ADS programs

Competency: Create custom menus

Competency Builders:

Demonstrate search routines when using a text editor
Write screen menus and macros
Write tablet menus and macros
Write cascading pop-down menus and macros
Write icon menus and macros
Write button menus and macros
Write other customizable CADD files (e.g., ACADD.PCP)
Edit other customizable CADD files (e.g., ACADD.PCP)

Competency: Create script files

Competency Builders:

Write a slide show script
Write a script for setting initial variable settings
Write a script for creating a title-block

Competency: Create custom linetypes

Competency Builders:

Formulate a linetype composed of long dashes
Formulate a linetype composed of lines, dashes and dots

Competency: Create 3-D wireframe models

Competency Builders:

Differentiate among extrusions, wireframes, surface models, and solid models
Create user coordinate systems
Manipulate user coordinate systems
Use cylindrical coordinates
Use spherical coordinates
Use .XYZ filters
Project geometry from one plane to another

Competency: Create 3-D surface models

Competency Builders:

Define B-rep surfaces
Differentiate B-rep surfaces and non-uniform rational B-splines (NURB's)
Create tabulated surfaces
Create ruled surfaces
Create revolved surfaces
Create edge surfaces (e.g., coon's patch)
Apply surface meshes to 3-D wireframes
Modify visibility of the edges of faces
Dimension a 3-D model for both isometric and orthographic drawings
Control dimension scale with regard to plotting scale

Competency: Apply advanced control display techniques

Competency Builders:

Define camera viewpoints and angle of rotation
Control display angle (e.g., d-view, v-point)

Unit: Advanced CADD

Competency: Create 3-D solid models

Competency Builders:

Differentiate B-rep solid modeling and Constructive Solid Geometry (CSG) modeling
Create solid primitives
Modify solid primitives
Create swept solids
Use Boolean operations to create complex solids (e.g., unions, subtractions, intersections, separations)
Fillet solid models
Chamfer solid models
Extract mass properties from a solid model
Create 2-D profiles and sections from a solid model
Explain the limitations of solid modeling
List intersection properties

Competency: Apply advanced display control

Competency Builders:

Use clipping planes to section a model
Apply perspective views
Place camera and target points to locate views
Place lights for rendering
Control lights for rendering
Create rendered images of surface and solid models

Competency: Write programs using AutoLISP

Competency Builders:

Perform simple math functions
Perform nested math functions
Write a routine which prompts for user input, performs calculations and creates or edits geometry
Identify common error codes
Format a program to display balanced parentheses and nesting of functions
Write a program including an "if/then/else" statement

Competency: Configure a CADD station

Competency Builders:

Install CADD software
Configure display drivers
Configure printer/plotter drivers
Configure input drivers

Competency: Prepare electrical/electronic CADD drawings

Competency Builders:

Interpret basic electric/electronic standards and symbols
Prepare schematic drawings
Prepare cable drawings
Prepare component drawings
Prepare logic diagrams
Prepare control panel drawings
Prepare connection drawings
Prepare interconnection drawings
Prepare printed circuit board drawings
Prepare harness drawings
Prepare packaged drawings
Prepare wiring diagrams
Prepare enclosure drawings
Prepare installation drawings
Prepare flow charts
Prepare symbol library
Modify drawings

Competency: Prepare pneumatic/hydraulic CADD drawings

Competency Builders:

Interpret basic pneumatic/hydraulic standards and symbols
Prepare piping drawings
Prepare isometric drawings
Prepare sectional diagrams
Prepare graphical symbols
Prepare process and instrumentation diagrams
Prepare combination diagrams
Prepare pump and motor drawings
Prepare cylinder and piston diagrams
Prepare valve drawings
Prepare pump section drawings
Prepare installation drawings
Prepare symbol library

Competency: **Prepare structural CADD drawings**

Competency Builders:

Use structural and reinforcing concrete manuals and technical tables
Detail structural beam connections
Detail concrete reinforcements
Prepare materials take off list
Draw structural framing plans and elevations
Identify welding symbols
Prepare symbol library

Unit: Fundamentals of Machine Anatomy

Competency: Interpret specifications for a machine

Competency Builders:

Identify power source
Identify power transmission
Identify hydraulic/pneumatic actuators
Identify materials
Identify fits/tolerances
Identify GD&T symbols
Identify safety factors
Participate in concurrent engineering
Demonstrate knowledge of print reading

Competency: Build a machine to specifications

Competency Builders:

Install hydraulic and pneumatic actuators
Troubleshoot hydraulic and pneumatic actuators
Install motors
Troubleshoot motors
Install sensors
Troubleshoot sensors
Install PLC's
Troubleshoot PLC's
Install industrial controls
Troubleshoot industrial controls
Install power distribution systems
Troubleshoot power distribution systems
Install brakes and clutches
Troubleshoot brakes and clutches
Install lubrication system
Troubleshoot lubrication system

Unit: Computerized Numerical Control (CNC)

Competency: Demonstrate knowledge of CNC

Competency Builders:

Define numerical control (NC) and computerized numerical control (CNC)
Differentiate NC and CNC
Describe closed loop, open loop, and adaptive controls
Define point to point systems
Identify tool movement of point to point systems
Define continuous path systems
Identify tool movements of continuous path systems
Identify data input mediums
Explain the purpose of the post-processor
Define canned cycles
Identify computer memory types
Identify information stored relative to computer memory types
Differentiate hardware and software
Differentiate among CNC, machining centers, and robots
List advantages/disadvantages of CNC machining centers
Explain direct numerical control (DNC)

Competency: Perform preventive maintenance

Competency Builders:

Follow proper safety procedures
Clean CNC equipment
Lubricate CNC equipment
Check CNC equipment for wear and alignment

Competency: Apply CNC operations

Competency Builders:

Identify parts of the machine
Apply basic programming skills to a turning and a milling operation
Select proper work holders
Select proper cutting tools
Set machine parts to drawing tolerances
Use CAD/CAM for part program development

Competency: Prepare CNC program

Competency Builders:

Write a program manually in word address format
Write a program off line
Write a program manually in conversational program
Generate a program using CAD/CAM package
Program machine using manual data input (MDI) process

Competency: Program CNC operations

Competency Builders:

Apply ANSI drawing standards
Apply process planning from drawing to finished product
Analyze workpiece
Contrast differences in computer-assisted programming
Perform basic trigonometric computations
Perform special perception mathematical computations
Set chip load, feed rates and surface feet per minute limitations
Turn intersection points into segments (i.e., defined in terms of points, lines, and circles)
Debug program

Competency: **Load machine**

Competency Builders:

Load program from MDI and off-line programming station
Prepare work-holding device
Mount work-holding device
Secure workpiece
Set up reference and clearance points
Set up tooling
Select proper lubrication/coolant

Competency: **Operate CNC machine**

Competency Builders:

Load raw material
Start cycle
Monitor work in-process
Edit CNC programs
Demonstrate ability to halt running program
Apply proper safety procedures
Demonstrate proper cleaning of CNC machine

Competency: **Manufacture workpiece (e.g., rectangular, round, angular)**

Competency Builders:

Dry-run machine
Run part
Inspect part

Unit: Basic Materials Science

Competency: Demonstrate basic knowledge of metallurgy

Competency Builders:

Define metallurgy
Define metal forming (e.g., general process)
Identify forming industries (e.g., stamping, forging, fabricating)
Describe metal forming principles
Describe the metal forming process
Identify frequently used metals
Describe the crystalline structures of metals
Use periodic chart to evaluate metals
List chemical properties of common metals
List physical properties of common metals
Describe measures of metal strength
Identify examples of raw materials processed by hot rolling, cold rolling, forging, drawing, extrusion, spinning and powered metallurgy
Explain secondary finishing operations (e.g., paint, anodizing)

Competency: Demonstrate basic knowledge of heat treatment

Competency Builders:

Describe process of heat treating
Define types of heat treating (e.g., case hardening, annealing, drawing, stress relieving, tempering, quenching, critical temperature)

Competency: **Demonstrate basic knowledge of metal characteristics and formability**

Competency Builders:

Explain metal and formability basics
Explain metal grades and coatings
Explain part contour analysis
Explain tensile test
Explain LDH test
Explain bend test
Explain hold expansion test
Explain R-value test
Explain hardness test
Explain cup test
Explain friction test
Explain surface test
Explain interpretation of metal characteristics tests
Describe blank/die interactions (e.g., friction)
Describe friction and forming process
Describe circle grid basics
Describe circle grid applications
Describe formability diagnostics
Describe the documentation process

Competency: **Demonstrate basic knowledge of casting**

Competency Builders:

Identify frequently used metals
Describe crystalline structures of metals
Use periodic chart in evaluating metals
List chemical properties of common metals
List physical properties of common metals
Define permanent mold casting
Define shell mold casting
Define sand casting and pattern making
Define die casting
Identify basic casting terms
Identify advantages/disadvantages of casting processes

Competency: **Demonstrate basic knowledge of iron and its alloys**

Competency Builders:

Define iron and its alloys
Describe iron manufacturing process
Describe the structure of iron and its alloys
List chemical properties of iron and its alloys
List physical properties of iron and its alloys
Describe iron and alloys property variables
Describe measures of strength for iron and its alloys
Identify examples of iron and its alloys processed by hot rolling, stamping, cold rolling, drawing, extrusion, spinning, casting, forging and machining
Perform tensile test
Perform Brinell test
Perform chemical analysis

Competency: **Demonstrate basic knowledge of aluminum and its alloys**

Competency Builders:

Define aluminum and its alloys
Describe aluminum manufacturing process
Describe the structure of aluminum
List chemical properties of aluminum
List physical properties of aluminum
Describe aluminum property variables
Identify examples of aluminum processed by cold rolling, drawing, extrusion, stamping, spinning, casting, forging and machining
Perform tensile test
Perform Brinell test
Perform chemical analysis

Competency: **Demonstrate basic knowledge of copper and its alloys (e.g., brass, bronze)**

Competency Builders:

Define copper and its alloys
Describe copper manufacturing process
Describe the structure of copper
List chemical properties of copper
list physical properties of copper
Describe copper property variables
Describe measures of copper strength
Identify examples of copper processed by cold rolling, drawing, extrusion, stamping, spinning, casting, forging and machining
Perform tensile test
Perform Brinell test
Perform chemical analysis

Competency: **Demonstrate basic knowledge of plastics and polymers**

Competency Builders:

Define thermo-analysis testing (e.g., melt flow, moisture control)
Define plastics and polymers
Describe plastics and polymers manufacturing processes
Describe structure of plastics and polymers
List chemical properties of plastics and polymers
List physical properties of plastics and polymers
Differentiate thermoset and thermoplastic
Describe plastics and polymer property variables
Describe measure of plastic and polymer strength
Identify examples of raw materials processed by machining, extrusion, stamping, injection molding, compression molding and injection compression molding
Identify molding defect (e.g., flash, sink marks, warp, contamination, wet material, stuck parts, short shot, burn marks, surface blemishes)
Identify secondary operations performed on plastic parts (e.g., plating, milling, painted)
Perform tensile test
Perform R-value test

Competency: **Demonstrate basic knowledge of concrete and other ceramics**

Competency Builders:

Explain concrete tools and applications (e.g., float, chairs)
Describe the formation of concrete
List types of cements and their uses
Define qualities of concrete (i.e., strength, consistency, homogeneity, tensile force, abrasion, heat of hydration, and heat and sulfate resistance)
List tests used in concrete production (e.g., slump test, test of fineness modules)
List protective practices used after pouring

Competency: **Demonstrate knowledge of corrosion and protection**

Competency Builders:

Identify causes of corrosion
Identify types of corrosion
List solutions to minimize problems
Identify corrosion testing

Competency: **Demonstrate basic knowledge of rubber manufacturing**

Competency Builders:

Explain history of rubber industry
Compare properties of natural rubber with those of synthetic rubber
Explain how natural rubber is manufactured
Explain vulcanizaton, mastication, and cure systems
Explain use of compounding ingredients (e.g., carbon blacks, accelerators, fillers, antioxidants)
Explain press and autoclave curing
Explain how synthetic rubber is manufactured (e.g., neoprene, butyl, styrene-butadiene)
Explain rubber testing (e.g., tensile, durometer)

Unit: Metal Stamping Dies

Competency: Describe different types of dies

Competency Builders:

Describe crimping die
Describe parts assembly die
Describe CAM bending die
Describe blanking die
Describe pierce die
Describe forming die
Describe draw die
Describe progressive die

Competency: Describe fixtures

Competency Builders:

Describe crimping fixture
Describe locating fixture
Describe press fitting fixture
Describe riveting fixture
Describe welding fixture

Competency: Design product

Competency Builders:

Draw isometric view of product
Construct model (e.g., clay, form, wood, plastic)
Scan model
Wire frame data
Create computerized model
Interface model with CAD/CAM
Reproduce surface finish
Identify materials for product
Create prototype
Validate product
Standardize product

Competency: Troubleshoot design errors

Competency Builders:

Isolate cause of die component breakage
Isolate cause of failure of parts to be removed from die
Isolate cause of incorrect punch clearance
Isolate cause of incorrect die clearance
Isolate cause of misfitting die components

Competency: Correct design errors

Competency Builders:

Correct cause of die component breakage
Correct cause of failure of parts to be removed from die
Correct cause of improper punch clearance
Correct cause of improper die clearance
Correct cause of misfitting die components

Competency: Explain die processing

Competency Builders:

Describe preplanning activities
Describe die layout
Identify die operations (e.g., number, purpose and sequence of die operations)
Describe feasibility study development
Describe sequence of operations from die construction

Competency: **Explain pattern shop applications**

Competency Builders:

Describe pattern shop activities
Describe die pattern materials (e.g., wood, styrofoam, ceramic)
Describe die pattern construction
Describe casting of dies
Describe casting of components
Describe model process steps
Describe model use

Competency: **Explain die construction (e.g., production and operation techniques)**

Competency Builders:

Explain need for basic machining skills
Explain need for sculptured machining skills
Explain EDM functions
Explain die material standards
Describe tool and die welding
Describe punch finishing
Explain lifter/gauging systems
Explain pressure systems
Describe function of cams

Competency: **Explain the die tryout process**

Competency Builders:

Explain need to use analytical problem solving for die tryout
Describe process documentation
Describe die modification techniques
Describe blank modification techniques
Describe die buy-off
Describe die release
Describe part release
Describe die coatings
Describe die treatments

Competency: **Explain die maintenance**

Competency Builders:

Describe planned die maintenance
Describe predictive die maintenance
Describe preventive die maintenance
Describe die maintenance troubleshooting techniques
Describe die refurbishment techniques

Unit: Press Technology

Competency: Explain press operation

Competency Builders:

Identify types of presses
Describe functions of presses
Identify capacity of presses
Describe shuttheight
Identify operator safety devices

Competency: Demonstrate knowledge of press accessories

Competency Builders:

Describe function of monitors, proximity switches and die protection
Describe function of loaders
Describe function of roller levelers
Describe function of decoilers
Describe function of feeders
Describe function of transfer mechanisms
Describe function of lubricators and coolants
Describe processing of coil steel
Describe use of quick die change
Describe press set-up

Unit: Sheet Metal Fabrication

Competency: Demonstrate knowledge of sheet metal fabrication

Competency Builders:

Describe sheet metal fabricated products
Describe press working process
Describe process(es) of straightening metal
Describe metal finishing and coating
Explain bend allowances
Identify materials used for sheet metal fabricaton (e.g., hot roll, cold roll, aluminum, stainless)
Explain process of determining metal thicknesses
Explain process of layout
Explain process of fastening
Explain process of punch and die clearance and alignment
Demonstrate the capability to finish (cleaning, painting, plating)
Demonstrate CADD uses for layout

Competency: Describe types of metal fabrication manufacturing

Competency Builders:

Describe shear
Describe press brake
Describe cut-to-length lines
Describe roll forming
Describe CNC turret presses
Describe FMS cells

Competency: Layout sheet metal

Competency Builders:

Lay out 90° ells
Lay out 45° and 30° ells
Use radial line development to lay out
Use development by triangulation to lay out

Competency: Fabricate components

Competency Builders:

Layout design
Measure materials
Create pattern and/or prototype
Use hand tools
Cut materials
Form materials
Use fasteners
Spot weld

Competency: Perform sheet metal fabrication

Competency Builders:

Identify sheet metal fabrication jobs
Identify tools (e.g., manual and hand powered) needed
Fabricate round ells
Fabricate tees
Fabricate pyramids
Fabricate cones
Fabricate square to round transitions

TECH PREP

"GET SERIOUS . . . ABOUT SUCCESS"

Tool & Die Technician

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—NOTICE—

Each Tech-Prep Competency Profile developed should respond to the labor market demands of your Tech Prep Consortium. Therefore, the following pages should be examined carefully before being selected for use in TCP Part I. **[See "The TCP Process" for more information.]** For example, in some cases the number of units far exceeds the amount of content that can be covered within a 4 + 2 TPAD Program. All the units listed in this section will not necessarily apply to your situation, nor will all the competencies within each unit be appropriate. Note that several units appear within each specific occupation and would need to only appear once if you are compiling a cluster of occupations. **[See "TCP Matrix" and "How to Use the TCP Binder" for more information.]**

Unit: Communications Literacy

NOTE: This content was extracted from the 9-12 cluster of Ohio's Model Language Arts Program. Due to statewide initiatives other than Tech Prep, this literacy unit was not altered to meet competency-based criteria. Each literacy unit forms a critical link between academic teachers and members of business, industry, and labor. [See "The TCP Process" for more information.]

Subunit: Reading—Structure

Competencies:

RS1 Exhibit knowledge of language structure
RS2 Recognize that there may be more than one interpretation of reading selections
RS3 Recognize various literary devices
RS4 Recognize and discuss literary elements
RS5 Develop and use an increasingly sophisticated vocabulary gained through context
RS6 Apply knowledge of language structure to reading
RS7 Explain why there may be more than one interpretation of reading selections
RS8 Recognize effect of literacy devices on meaning
RS9 Analyze author's use of literary elements
RS10 Recognize relationship of structure to meaning
RS11 Describe various interpretations and meaning levels in reading selections
RS12 Characterize author's use of literary devices
RS13 Characterize use of literary techniques
RS14 Critique a variety of literature with regard to plot, dialogue, theme, setting, and characterization
RS15 Apply an expanding vocabulary gained through reading
RS16 Explain various interpretations and meaning levels in reading selections
RS17 Analyze use of literary techniques (e.g., extended metaphor, simile, personification, hyperbole, pun, alliteration)
RS18 Understand use of literary devices (e.g., irony, satire, allegory, onomatopoeia)
RS19 Analyze and synthesize pieces of literature with regard to plot, dialogue, theme, setting, and characterization

Subunit: Reading—Meaning Construction
Competencies:

RM1	Demonstrate ability to recognize appropriate pre-reading strategies
RM2	Describe effectiveness of a reading selection
RM3	Read to clarify personal thinking and knowledge
RM4	Support interpretation of text by locating and citing specific information
RM5	Develop personal response to a variety of literary works
RM6	Recognize diverse literary interpretations
RM7	Engage in self-selected reading activities
RM8	Confirm and extend meaning in reading by researching new concepts and facts
RM9	Self-monitor and apply corrective strategies when communication has been interrupted or lost
RM10	Use features of literary genres to extend meaning
RM11	Assess effectiveness of a selection read
RM12	Use reading as a possible problem-solving strategy to clarify personal thinking and knowledge
RM13	Use knowledge of semantic elements (e.g., figurative language, denotation, connotation, dialect) to clarify meaning when reading
RM14	Predict, recognize, interpret, and analyze themes based on familiarity with author's work
RM15	Compare and contrast literary genres
RM16	Assess validity and quality of selection read
RM17	Clarify meaning when reading
RM18	Compare personal reaction to critical assessment of a literary selection
RM19	Assess validity of diverse literary interpretations
RM20	Use reference books to find, evaluate, and synthesize information
RM21	Identify tone of a literary work
RM22	Critique validity of diverse literary interpretations
RM23	Integrate personal reaction to and critical assessment of a literary selection

Subunit: Reading—Application
Competencies:

RA1	Select and read material for personal enjoyment and information
RA2	Read a variety of complete, unabridged works
RA3	Employ various reading strategies according to purpose
RA4	Participate in selection of books, materials, and topics for literature study groups
RA5	Develop and apply knowledge of the interrelationship of concepts
RA6	Read selections from a variety of styles and formats, recognizing that style and format influence meaning
RA7	Extend value of reading, writing, speaking, viewing, and listening by pursuing, through reading, new concepts and interests developed as a result of these activities
RA8	Read extensively from a particular author's work and explain elements
of	author's style

Subunit: Reading—Multidisciplinary
Competencies:

RM1	Connect themes and ideas across disciplines through literature
RM2	Read to facilitate learning across curriculum
RM3	Read to develop awareness of human rights and freedom
RM4	Participate actively in a community of learners
RM5	Recognize and explain interaction between literature and various cultural domains (e.g., social technological, political, economic)
RM6	Explore and analyze a variety of cultural elements, attitudes, beliefs, and value structures by men and women of many racial, ethnic, and cultural groups
RM7	Value thinking and language of others
RM8	Relate literature to historical period about which or in which it was written
RM9	Read to facilitate content learning

Subunit: Writing—Structure
Competencies:

WS1 Develop and expand a repertoire of organizational strategies (e.g., narration, comparison/contrast, and description) through a practice and discussion

WS2 Clarify word choice according to audience, topic, and purpose

WS3 Locate and correct errors in usage, spelling, and mechanics using a variety of resources

WS4 Recognize information gained from primary and secondary sources

WS5 Develop writing which contains ordered, related, well-developed paragraphs with sentences of varied lengths and patterns

WS6 Use information from a variety of sources to develop an integrated piece of writing

WS7 Evaluate and revise writing to focus on such things as audience, tone, and purpose

WS8 Recognize differences between documentation and reference list styles

WS9 Develop extended pieces of writing which contain ordered, related, well-developed paragraphs with sentences of varied lengths and patterns

WS10 Select from a repertoire of organization strategies a pattern appropriate to a topic

WS11 Synthesize information from a variety of sources

WS12 Refine word choice and tone according to audience, situation, and purpose

WS13 Appropriately cite information gained from primary and secondary sources

WS14 Use style manuals or software to prepare documentation and reference lists

WS15 Develop effectively organized pieces of expository writing containing strong voice, clear thesis, and well-developed ideas

WS16 Identify organization patterns appropriate to writing topic

WS17 Respond to others' suggested revisions to a writing piece

Subunit: Writing—Meaning Construction
Competencies:

WM1	Demonstrate knowledge of the recursive nature of the writing process by applying it appropriately to various topics, situations, and audiences
WM2	Develop criteria for writing evaluation using scoring guides and peer/teacher assistance to clarify meaning
WM3	Respond to others' suggested revisions to a piece of writing
WM4	Use word processing, graphics, and publishing aids to construct meaning in writing
WM5	Engage in self-initiated writing activities
WM6	Incorporate personal criteria with generally accepted standards for writing evaluation
WM7	Evaluate, analyze, and synthesize information for writing
WM8	Evaluate own writing using personal and established scoring criteria
WM9	Assess personal/peer revisions to a writing piece
WM10	Recognize and refine personal writing styles

Subunit: Writing—Application
Competencies:

WA1	Apply appropriate writing techniques suitable for varied writing tasks
WA2	Use sentence-combining techniques to improve syntactic fluency and maturity
WA3	Write in response to prompted and self-selected topics in practical, persuasive, descriptive, narrative, and expository domains
WA4	Develop personal voice in writing
WA5	Consider audience and purpose for writing
WA6	Develop criteria for selection and potential development of topic
WA7	Write in a journal or learning log to clarify personal thinking and knowledge
WA8	Apply an expanding vocabulary gained through writing
WA9	Make judicious use of reference sources (e.g., dictionary, thesaurus, on-lien data base, encyclopedia)
WA10	Demonstrate, an appreciation for aesthetically pleasing language through word choice and style
WA11	Apply revising and editing strategies needed for writing task
WA12	Vary sentence lengths and patterns
WA13	Refine personal voice in writing
WA14	Vary styles and formats for intended purpose and audience
WA15	Apply criteria for selection and development of topic
WA16	Participate in peer review of writing in progress
WA17	Use transitions between sentences, ideas, and paragraphs in writing
WA18	Revise and edit papers extensively in preparation for presentation/publication
WA19	Develop a variety of genres
WA20	Focus writing and tone on such elements as audience, situation, and purpose
WA21	Develop topic fully and appropriately
WA22	Use writing process to clarify personal thinking and knowledge
WA23	Apply appropriate recursive writing process as suggested by writing task and writer's process
WA24	Develop an extended piece of writing
WA25	Revise writing and tone to assure focus on such elements as audience, situation, and purpose
WA26	Use writing process to write reflectively

Subunit: Writing—Multidisciplinary

Competencies:

WM1	Use writing process for learning across curriculum
WM2	Use writing process to demonstrate knowledge of need for human rights and freedom
WM3	Value and apply collaborative skills in writing process
WM4	Write in response to reading, speaking, viewing, and listening
WM5	Use multidisciplinary resources in writing projects
WM6	Use writing process to facilitate learning across curriculum
WM7	Recognize value of and engage in collaboration in writing process
WM8	Use communication processes to develop a published writing piece in collaboration with others
WM9	Record experiences and observations related to content learning
WM10	Apply collaborative skills in writing process
WM11	Write collaboratively with peers
WM12	Use cross-disciplinary resources in writing projects

Subunit: Listening/Visual Literacy—Structure

Competencies:

LS1	Listen to and view a wide variety of genres
LS2	Become aware of an author's style through listening and viewing a variety of works
LS3	Recognize correct and appropriate grammar, diction, and syntax
LS4	Expand vocabulary through listening to and viewing varied media
LS5	Recognize beauty of language
LS6	Enhance recognition of an author's style through listening and viewing a variety of works
LS7	Recognize use and misuse of language in media
LS8	Refine knowledge of style through listening and viewing multiple works by the same author
LS9	Expand and refine grammar, diction, and syntax through listening
LS10	Compare authors' styles through viewing and listening to their works
LS11	Expand knowledge of complex grammar, diction, and syntax issues

Subunit: Listening/Visual Literacy—Meaning Construction

Competencies:

LM1	Develop critical thinking skills necessary to evaluate media and assess oral presentations
LM2	Compare new oral texts to past experiences and knowledge in order to enhance comprehension
LM3	Recognize how rhythmic patterns, silence, and cadences enhance quality of speech and literature
LM4	Focus listening and viewing on themes and/or plots
LM5	Gather information from listening and viewing experiences to enhance research
LM6	Use critical thinking skills to evaluate media and oral presentations
LM7	Use prior knowledge and experiences to facilitate comprehension of new oral texts
LM8	Identify rhythmic and time patterns in speech and literature
LM9	Identify and analyze themes and/or plots when listening and viewing
LM10	Use information gathered from listening and viewing experiences to expand research
LM11	Enhance use of critical thinking skills to evaluate media and oral presentations
LM12	Consider prior knowledge and experiences when attempting to understand the meaning of new texts
LM13	Appreciate rhythmic and time patterns of speech and literature
LM14	Select viewing and listening materials to support written text
LM15	Evaluate media and oral presentations analytically and critically
LM16	Organize prior knowledge and experiences to comprehend new texts
LM17	Organize and use viewing and listening materials to support written text

Subunit: Listening/Visual Literacy—Application

Competencies:

LA1	Listen attentively during oral reading
LA2	Use media as stimuli for learning and thinking
LA3	Develop knowledge of structure through art, music, and literature
LA4	Use electronic media to enhance and highlight language learning
LA5	Listen and view for entertainment and enjoyment
LA6	Use technology and other media as means of expressing ideas

Subunit: Listening/Visual Literacy—Multidisciplinary

Competencies:

LM1	Facilitate learning across curriculum through critical listening and viewing
LM2	Engage in individual, small-group, and whole-group listening and viewing activities
LM3	Develop language arts (e.g., viewing, listening) projects collaboratively
LM4	Investigate language and cultural differences through listening and viewing activities
LM5	Participate in a community of learners through productive listening

Subunit: Oral Communication—Structure

Competencies:

OS1	Refine oral communication skills
OS2	Demonstrate knowledge of grammar, usage, and syntax when presenting
OS3	Select topics and vocabulary suitable to audience
OS4	Organize notes and ideas for speaking
OS5	Use language imaginatively
OS6	Modulate voice to meaning when interpreting literature orally
OS7	Organize notes and ideas for formal, semiformal and informal presentations of information
OS8	Refine speaking techniques for formal, semiformal, and informal settings
OS9	Develop repertoire of organizational strategies for presenting information orally
OS10	Expand vocabulary to fit topic
OS11	Select topics suitable to audience, situation, and purpose
OS12	Select appropriate strategies when organizing notes and ideas for speaking

Subunit: Oral Communications—Meaning Construction

Competencies:

OM1	Make connections between prior knowledge and new information for oral presentations
OM2	Participate in informal speaking activities
OM3	Use interviewing techniques to gather information
OM4	Communicate orally to entertain and to inform
OM5	Participate in group communication activities
OM6	Take and organize notes when preparing speech/presentation
OM7	Interpret texts orally to illustrate meaning
OM8	Respond to needs of various audiences
OM9	Gather and assess information for speaking
OM10	Communicate orally to inform and persuade
OM11	Prepare and deliver formal speech/presentation
OM12	Participate in a variety of oral interpretations
OM13	Assess needs of audience and adjust language and presentation according to their knowledge
OM14	Analyze and synthesize information for speaking
OM15	Describe effectiveness of literary selection
OM16	Describe topic or idea in order to clarify personal/audience thinking
OM17	Analyze and synthesize information gathered from a variety of sources for speaking
OM18	Describe validity and/or quality of a literary selection and justify selection
OM19	Interpret orally a variety of literature
OM20	Describe topic or idea to clarify meaning for others

Subunit: Oral Communication—Application

Competencies:

OA1	Become proficient at using interviewing techniques
OA2	Give an oral interpretation for a specific audience
OA3	Develop and apply oral communication skills for cooperative/collaborative learning
OA4	Use oral communication for a variety of purposes and audiences (e.g., negotiations, book reviews, rationales)
OA5	Develop and apply decision-making strategies
OA6	Practice interviewing techniques
OA7	Apply interviewing techniques to purposeful interviews
OA8	Focus oral interpretation on a specific audience

Subunit: Oral Communications—Multidisciplinary

Competencies:

OM1 Value thinking and language of others
OM2 Develop oral projects collaboratively
OM3 Be involved in individual, small-group, and whole-group language activities
OM4 Participate actively in a community of learners
OM5 Investigate language and cultural differences through oral language activities

Unit: Mathematics Literacy

NOTE: This content was extracted from the 9-12 cluster of Ohio's Model Mathematics Program. Due to statewide initiatives other than Tech Prep, this literacy unit was not altered to meet competency-based criteria. Each literacy unit forms a critical link between academic teachers and members of business, industry, and labor. [See "The TCP Process" for more information.]

Subunit: Numbers and Number Relations
Competencies:

NR1	Compare, order, and determine equivalence of real numbers
NR2	Estimate answers, compute, and solve problems involving real numbers
NR3	Compare and contrast real number system, rational number system, and whole number system
NR4	Extend knowledge to complex number system and develop facility with its operation

Subunit: Measurement
Competencies:

M1	Estimate and use measurements
M2	Understand need for measurement and probability that any measurement is accurate to some designated specification
M3	Understand and apply measurements related to power and work
M4	Understand and apply measurement concepts of distance-rate-time problems and acceleration problems
M5	Use real experiments to investigate elasticity, heat, sound, electricity, magnetism, light, acceleration, velocity, energy, and gravity
M6	Use real-world problem situations involving mass and weight
M7	Use real-world problem situations involving simple harmonic motion
M8	Establish ratios with and without common units
M9	Construct and interpret maps, tables, charts, and graphs as they relate to real-world mathematics
M10	Understand and solve rate-change problems
M11	Understand and solve right triangle relationships as they relate to measurement, specifically to Pythagorean theorem
M12	Graph and interpret ordered pairs
M13	Compute total sales from a variety of items
M14	Comprehend and compute rates of growth or decay
M15	Comprehend, compute, and interpret real problems involving annuities

Subunit: Measurement (continued)
Competencies:

M16	Develop an ability to identify real problems and provide possible solutions
M17	Express and apply different types of measurement scales
M18	Identify area and volume

Subunit: Estimation and Mental Computation
Competencies:

E1	Use estimation to eliminate choices in multiple-choice tests
E2	Use estimation to determine reasonableness of problem situations in a wide variety of applications
E3	Estimate shape of graphs of various functions and algebraic expressions
E4	Use mental computation when computer and calculator are inappropriate

Subunit: Data Analysis and Probability
Competencies:

D1	Organize data into tables, charts, and graphs
D2	Understand and apply measures of central tendency, variability, and correlation
D3	Use curve fitting to predict from data
D4	Use experimental or theoretical probability, as appropriate, to represent and solve problems involving uncertainty
D5	Use computer simulations and random number generators to estimate probabilities
D6	Test hypotheses using appropriate statistics
D7	Read, interpret, and use tables, charts, and graphs to identify patterns, note trends, draw conclusions, and make predictions
D8	Identify probabilities of events involving unbiased objects
D9	Use sampling and recognize its role in statistical claims
D10	Design a statistical experiment to study problem, conduct experiment, and interpret and communicate outcomes
D11	Describe normal curve in general terms and use its properties
D12	Create and interpret discrete probability distributions
D13	Understand concept of random variable
D14	Apply concept of random variable to generate and interpret probability distributions, including binomial, uniform, and chi square

Subunit: Algebra
Competencies:

A1	Describe problem situations by using and relating numerical, symbolic, and graphical representations
A2	Use language and notation of functions in symbolic and graphing settings
A3	Recognize and use equivalent zeros of a function, roots and the solution of an equation in terms of graphical and symbolic representations
A4	Describe and use logic of equivalence in working with equations, inequalities, and functions
A5	Develop graphical techniques of solution for problem situations involving functions
A6	Explore and describe characterizing features of functions
A7	Make arguments and proofs in algebraic settings
A8	Factor difference of two squares
A9	Identify slope, midpoint, and distance
A10	Explore and combine rational functions
A11	Explore factoring techniques
A12	Solve quadratic equations by factoring and formula
A13	Set up and solve linear equations
A14	Solve systems of linear equations with two variables
A15	Describe geometric situations and phenomena using variables, equations, and functions
A16	Describe measures of central tendency, mean, median, mode, and variance algebraically and graphically
A17	Represent inequalities on number line and in coordinate plane
A18	Use coordinate arguments in making geometric proofs
A19	Symbolize transformations of figures and graphs
A20	Explore geometric basis for functions of trigonometry
A21	Graph linear functions
A22	Develop and use vectors to represent direction and magnitude including operations
A23	Use polar and parametric equations to describe, graph, and solve problem situations
A24	Represent sequences and series as functions both algebraically and graphically
A25	Explore recursive functions and procedures using spreadsheets, other computer utilities, and appropriate notions
A26	Describe and solve algebraic situations with matrices
A27	Describe and use inverse relationship between functions including exponential and logarithmic

Subunit: Algebra (continued)
Competencies:

A28 Analyze and describe errors and error sources that can be made when using computers and calculators to solve problems
A29 Decide whether problem situation is best solved using computer, calculator, paper and pencil, or mental arithmetic/estimation techniques
A30 Explore relationships between complex numbers and vectors
A31 Make arguments concerning limits, convergence and divergence in context involving sequences, series, and other types of functions
A32 Represent transformations in plane with matrices
A33 Contrast and compare algebra's of rational, real, and complex numbers with characteristics of a matrix algebra system
A34 Construct polynomial approximations of a function over specified intervals of convergence
A35 Examine complex numbers as zeros of functions
A36 Translate verbal statements into symbolic language
A37 Simplify algebraic expressions
A38 Use laws and exponents (including scientific notation)
A39 Expand and extend idea of vectors and linear algebra to higher dimensional situations
A40 Use the idea of independent basis elements for a vector space and associated fundamental concepts of finite dimensional linear algebra
A41 Develop and communicate arguments about limit situations
A42 Use matrices to describe and apply transformations
A43 Develop and use polar and parametric equations to represent problem situations
A44 Explore proofs by mathematical induction

Subunit: Geometry
Competencies:

G1	Create and interpret drawings of three-dimensional objects
G2	Represent problem situations with geometric models and apply properties of figures
G3	Apply Pythagorean theorem
G4	Demonstrate knowledge of angles and parallel and perpendicular lines
G5	Explore inductive and deductive reasoning through applications to various subject areas
G6	Translate between synthetic and coordinate representations
G7	Identify congruent and similar figures using transformation with computer programs
G8	Deduce properties of figures using transformations and coordinates
G9	Use deductive reasoning
G10	Explore compass and straightedge constructions in context of geometric theorems
G11	Demonstrate knowledge of and ability to use proof
G12	Use variety of proof techniques (e.g., synthetic, transformational, and coordinate)
G13	Use variety of proof formats, including T-proof (i.e., two-column) and paragraph proof
G14	Explore different proof strategies
G15	Investigate different proofs of theorems
G16	Develop knowledge of an axiomatic system
G17	Apply transformations and coordinates in problem solving
G18	Represent problem situations with geometric models and apply properties of figures
G19	Deduce properties of figures using vectors
G20	Analyze properties of Euclidean transformations and relate translations to vectors
G21	Apply vectors in problem solving
G22	Develop further knowledge of axiomatic systems by investigating and comparing various geometry's

Subunit: Patterns, Relations, and Functions
Competencies:

P1	Model real-world phenomena with polynomial and exponential functions
P2	Explore relationship between zeros and intercepts of functions
P3	Translate among tables, algebraic expressions, and graphs of functions
P4	Use graphing calculator or computer to generate graph of a function
P5	Explore relationship between a linear function and its inverse
P6	Describe and use characteristics of polynomial functions in problem-solving situations
P7	Explore conic sections and graph using graphing calculator or computer
P8	Apply trigonometric functions to problem situations involving triangles
P9	Discover relationships between algebraic description, kind, and properties of conic
P10	Explore periodic real-world phenomena using sine and cosine functions
P11	Analyze effects of parameter changes on graphs
P12	Use graphing calculator or computer to graph functions
P13	Develop an knowledge of rational and transcendental functions
P14	Understand connections between trigonometric and circular functions
P15	Use circular functions to model periodic real-world functions
P16	Solve trigonometric equations and verify trigonometric identities
P17	Understand connections between trigonometric, exponential, and logarithmic functions and polar coordinates, complex numbers, and series
P18	Model real-world phenomena with a variety of functions
P19	Graph using polar coordinates
P20	Explore graphs in three dimensions
P21	Explore functions of several variables
P22	Explore recursive functions using spreadsheets and/or programming languages

Unit: Science Literacy

NOTE: This content was extracted from the 9-12 cluster of Ohio's Draft Model Science Program. Due to statewide initiatives other than Tech Prep, this literacy unit was not altered to meet competency-based criteria. Each literacy unit forms a critical link between academic teachers and members of business, industry, and labor. [See "The TCP Process" for more information.]

Subunit: Scientific Inquiry

Competencies:

Q1	Check the appropriateness and accuracy of measures and computations using various strategies (e.g., estimations, unit analysis, determination of significant figures)
Q2	Use ratios, proportions, and probabilities in appropriate problem situations
Q3	Translate information from and represent information in various forms with equal ease (e.g., tables, charts, graphs, diagrams, geometric figures)
Q4	Use existing algebraic formulas and create new ones in appropriate problem-solving situations
Q5	Estimate and justify probabilities of outcomes of familiar situations based on experimentation and other strategies
Q6	Invent apparatus and mechanical tools needed to perform unique tasks in various situations
Q7	Identify, compare, and contrast different modes of inquiry, habits of mind, and attitudes and dispositions
Q8	Design investigations that are safe and ethical (i.e., obtain consent and inform others of potential outcomes, risks and benefits, and show evidence of concern for human health and safety, concern for non-human species)
Q9	Make and read scale drawings, maps, models, and other representations to aid planning and understanding
Q10	Seek elaboration and justification of data and ideas, and reflect on alternative interpretations of the information
Q11	Use appropriate units for counts and measures
Q12	Create and use databases (electronic and other) to collect, organize, and verify data and observations
Q13	Design and conduct investigations with multiple variables
Q14	Communicate the results of investigations clearly in a variety of situations

Subunit: Scientific Inquiry (continued)
Competencies:

Q15 Examine relationships in nature, offer alternative explanations for the observations, and collect evidence that can be used to help judge among explanations

Q16 Trace the development (e.g., history, controversy, and ramifications) of various theories, focusing on supporting evidence and modification with new evidence

Q17 Select, invent, and use tools, including analog and digital instruments, to make and record direct measurements

Q18 Observe and document events and characteristics of complex systems

Q19 Explain the influence of perspective (e.g., spatial, temporal, and social) on observation and subsequent interpretations

Q20 Create multiple representations of the same data using a variety of symbols, descriptive languages, mathematical concepts, and graphic techniques

Q21 Generate testable hypotheses for observations of complex systems and interactions

Q22 Document potentially hazardous conditions and associated risks in selected homes and public areas

Q23 Participate in public debates, relying on documented and verified data to construct and represent a position on scientific issues

Q24 Construct and test models of physical, biological, social, and geological systems

Q25 Read, verify, debate, and, where necessary, refute research published in popular or technical journals of science (e.g., *Discover*, *Omni*, *Popular Mechanics*)

Q26 Explore discrepant events and develop and test explanations of what was observed

Q27 Conduct theory-based research using surveys, observational instruments, and other methods

Q28 Modify personal opinions, interpretations, explanations, and conclusions based on new information

Q29 Analyze error and develop explanations in various domains

Q30 Formulate taxonomic schemes based upon multivariate models that help to explain similarities and differences in form, distribution, behavior, survival, and origin of objects and organisms

Q31 Demonstrate various logical connections between related concepts (e.g., entropy, conservation of energy)

Q32 Account for discrepancies between theories and observations

Q33 Analyze the changes within a system when inputs, outputs, and interactions are altered

Subunit: Scientific Inquiry (continued)
Competencies:

Q34 Create, standardize, and document procedures
Q35 Determine the sources of significant disparities between the predicted and recorded results and change research procedures to minimize disparities
Q36 Research, locate, and propose applications for abstract patterns (e.g., fractals, Fibonacci sequences, string theory, orbitals)
Q37 Recognize and utilize classification systems for particles, elements, compounds, phenomena, organisms, and others for exploring and predicting properties and behaviors
Q38 Suggest and defend alternative experimental designs and data explanations (e.g., sampling, controls, safeguards)
Q39 Recognize and communicate differences between questions that can be investigated in a scientific way and those that rely on other ways of knowing
Q40 Draw conclusions based on the relationships among data analysis, experimental design, and possible models and theories
Q41 Suggest new questions as a result of reflection on and discussions about their own scientific investigations
Q42 Investigate, assess, and comment on strengths and weakness of the descriptive and predictive powers of science
Q43 Create new information from representations of data in a variety of forms (e.g., symbols, descriptive languages, graphic formats) utilizing a variety of techniques (e.g., interpolations, extrapolations, linear regressions, central tendencies, correlation's)

Subunit: Scientific Knowledge
Competencies:

K1 Investigate various types of dynamic equilibrium (e.g., biological, geological, mechanical, chemical)

K2 Investigate the relationship between the rates of energy exchange and the relative energy level of components with systems (e.g., tropic levels of ecosystems, osmosis, rate of heating and cooling, storms)

K3 Investigate patterns in the natural world (e.g., heredity, crystalline structures, population and resource distributions, diffraction, dispersion, polarization)

K4 Investigate models and theories that help to explain the interactions of components in systems (e.g., conservation of mass, energy, and momentum; food webs; natural selection; entropy; plate tectonics; chaos; relativity; social-psychology)

K5 Investigate degrees of kinship among organisms and groups of organisms

K6 Investigate the limits of the definition of life, and investigate organisms and physical systems that exist at or near these limits (e.g. viruses, quarks, black holes)

K7 Investigate estimates and measurements of a wide range of distances and rates of change

K8 Investigate the historical development of theories of change over time (e.g., natural selection, continental drift, the big bang, geologic change)

K9 Investigate physical and chemical changes in living and non-living systems (e.g., photosynthesis, weathering processes, glaciation, thermal effects of materials, energy cells)

K10 Investigate simulations of nuclear change (e.g., radioactivity, half life, carbon dating)

K11 Investigate conservation principles associated with physical, chemical, and nuclear changes

K12 Formulate descriptions of the impacts of various forms of mechanical and electromagnetic waves on various organisms on each other over time

K13 Formulate models and hypotheses for patterns in the natural world (e.g., earth structures, transportation systems, migrations, communications, constellations)

K14 Formulate explanations for the influences of objects and organisms on each other over time

K15 Formulate and interpret explanations for change phenomena (e.g., mass extinction's, stellar evolution, punctuated equilibrium, molecular synthesis)

Subunit: Scientific Knowledge (continued)
Competencies:

K16 Formulate and interpret explanations for the magnitudes of diversity at different periods of geologic time (e.g., mutation, global cataclysms, continental drift, competition, mass extinction's)

K17 Formulate interpretations of the structure, function, and diversity in a variety of organisms and physical systems (e.g., DNA and RNA variants, nucleons, interaction particles)

K18 Formulate understandings of geologic time (e.g., millennia, periods, epochs)

K19 Formulate an understanding of the historical development of the model of the universe

K20 Formulate explanations and representations of the production, transmission, and conservation of energy in biological and physical systems (e.g., weather, volcanism, earthquakes, electricity, magnetism, cellular respiration)

K21 Formulate models and hypotheses about patterns in the natural world (e.g., social behavior, molecular structure, energy transformation, entropy, randomness, aging, chaos, hormonal cycles)

K22 Formulate interpretations of the relationship between energy exchange and the interfaces between components within systems

K23a Formulate estimations for the range of energies within and between various phenomena (e.g., thermal, electromagnetic, thermonuclear, chemical, electrical)

K23b Formulate explanations for the historical development of descriptions of motions interactions and transformations of matter and energy (e.g., classical Newtonian mechanics, special and general relativity, chaos)

K24 Formulate models that can be used to describe fundamental molecular interactions in living and non-living systems (e.g., cell membranes, semiconductors).

K25 Formulate an understanding of the degree of relationship among organisms and objects based on molecular structure (e.g., proteins, nucleic acids)

K26 Formulate hypotheses and models that may account for observable events (e.g., electricity and magnetism, gravitation, atoms, bonding, chemical reactions, quantum effects, energy flow on biological systems, predator-prey relationships)

K27 Formulate models and hypotheses about change over time (e.g., natural selection, speciation, punctuated equilibrium, phyleytic gradualism, stellar evolution, plate tectonics, radioactive decay, quantum mechanical theory)

Subunit: Scientific Knowledge (continued)
Competencies:

K28 Formulate lists of limitations and propose refinements of standard classification systems (e.g., periodic table, IUPAC, Linnean, standard model)

K29 Formulate specific cases of limitations and possible exceptions of theories and principles regarding the interactions of moving objects and organisms (e.g., fluid flow in vessels, motion near the speed of light, Heisenberg uncertainty principle, meteorological prediction, local variation and diversity, predicting earthquakes, energy transport in cellular respiration)

K30 Formulate plans and contingencies that can be used to accommodate for changes to and stresses on systems (e.g., wildlife and habitat management, corrosion prevention, noise abatement, structure design)

K31 Formulate models of molecular, atomic, ionic, and subatomic structures and the physical and biological implications of these structures (e.g., genes, nucleons, quarks)

K32 Formulate estimates for a wide range of measurements and scales (e.g., angstroms to light years)

K33 Formulate and interpret representations of time from origin to present accounting for phenomena of scale (e.g., smoothness, punctuation's, chaos)

K34 Formulate interpretations of the historical development of various theories of possible causes of diversity among physical and biological phenomena (e.g., the works of Aristotle, Mendel, Darwin, McClintock)

K35 Formulate models and hypotheses that can be used to explain the interactions of components within technological and ecological systems

Subunit: Conditions for Learning Science
Competencies:

C1 Participate actively in dialogue about and resolution of community issues
C2 Assess information from various countries in the original language or translated form to ascertain the perspectives of many cultures
C3 Analyze the scientific ideas presented in science fiction stories and films
C4 Perform and repeat investigations to verify data, determine regularity, and reduce the impact of experimental error
C5 Present the results of investigations in a variety of forums
C6 Contribute to the decisions regarding topics for investigation
C7 Use various creative means to communicate interpretations of scientific ideas, concepts, phenomena, and events
C8 Consider the scientific thinking and language of others
C9 Individually and collaboratively produce clearly written representations of investigative results
C10 Fulfill responsibilities as part of a research group
C11 Select and utilize resources by various criteria (e.g., efficiency, effectiveness, health, safety) that are appropriate to the investigations being conducted by groups
C12 Present persuasive argument based on the scientific aspects of controversial issues
C13 Collect, store, retrieve, and manipulate information with available t technologies alleges that may range from hand processes up through computer applications
C14 Investigate social issues with a scientific perspective (e.g., human rights, wellness, economics, futurism, environmental ethics)
C15 Keep journals of observations and inferences made over an extended period of time and reflecting upon the impact of these recorded ideas on their thinking and actions
C16 Examine the intellect, perspectives, and ethics of notable scientists
C17 Collect and analyze observations made over extended periods of time and compare these to scientific theories
C18 Create presentations of scientific understandings using diverse modes of expressions
C19 Conduct formal scientific debates in the classroom
C20 Wonder about the likelihood of events that may occur by chance or coincidence
C21 Plan and conduct field trips and experiences for small and large groups
C22 Analyze the historical context which leads to and has lead to scientific t theories

Subunit: Conditions for Learning Science (continued)
Competencies:

C23 Seek information on topics of personal scientific interest from a variety of sources
C24 Conduct learner-developed investigations independently and collaboratively over periods of week and months
C25 Listen attentively and critically to presentations of scientific information made by others
C26 Conduct analyses of propaganda related to scientific issues
C27 Perform investigations that require observations over varying periods of time
C28 Experience scientific concepts as interpreted by other cultures through multimedia and local and global specialists
C29 Access appropriate technology to perform complicated, time-consuming tasks
C30 Relate historical accounts of science to the cultural context in which they were written
C31 Work as a contributing member of a collaborative research group
C32 Examine the influences of social and political structures and realities that contribute to inquiry about scientific issues
C33 Use technology (e.g., desktop publishing, teleconferencing, networking) to communicate scientific ideas
C34 Explore and analyze a variety of perspectives on science (e.g., works by men and women of many racial, ethnic, and cultural groups)
C35 Lead groups of learners of various ages in designing, planning, and conducting science activities
C36 Respect the scientific thinking of others and self
C37 Recognize and contrast different epistemologies
C38 Develop possible courses of action in response to scientific issues of local and global concern
C39 Determine the validity of research conclusions in relation to the design, performance, and results
C40 Develop multimedia presentations of group and individual research projects and investigations appropriate for a variety of audiences and forums
C41 Produce interesting and scientifically correct stories and present them using various modes of expression
C42 Reflect on the ideas and content found in their own journal records
C43 Examine ambiguous results and formulate explanations
C44 Recognize and synthesize the contributions to scientific thought of individuals from many cultures

Subunit: Conditions for Learning Science (continued)
Competencies:

C45 Construct models and simulations of the component structures and functions of living and non-living entities
C46 Lead multi-age groups in the examination of and planned resolution for scientific issues
C47 Recognize and choose members of research teams based upon the merit of their ideas and skills
C48 Construct a portfolio of products, documentation, and self-evaluations of his/her own abilities, skills, and experiences
C49 Synthesize scientific information from a variety of sources
C50 Evaluate and prioritize scientific issues based upon risk-benefit analyses
C51 Refining scientific skills from a variety of experiences

Subunit: Applications for Science Learning

Competencies:

A1 Answer student-determined questions by designing databases and drawing inferences from the analyses of the information in these data bases

A2 Make personal behavior decisions by interpreting information that has a scientific basis

A3 Propose courses of action that will validate and demonstrate personal understandings of scientific principles

A4 Guide other learners in their understanding of the interactions of technologies and society at various periods in time

A5 Promote and carry out practices that contribute to a sustainable environment

A6 Study and propose improvements in public services and systems in their community

A7 Choose consumer materials utilizing personal and environmental risk and benefit information

A8 Make inferences and draw conclusions using databases, spreadsheets, and other technologies

A9 Do simple trouble-shooting on common electrical and mechanical systems, identifying and eliminating possible causes of malfunctions

A10 Construct devices that perform simple, repetitive actions

A11 Investigate the functionality of various geometric shapes in the natural world and the designed world (e.g., translations from spherical to plane representations cause distortions, triangular shapes contribute to rigidity and stability in structures, round shapes minimize boundary for a given capacity)

A12 Make decisions regarding personal and public health

A13 Evaluate the social and ecological risks and benefits resulting from the use of various consumer products

A14 Analyze the contributions of advances in technology through history to his/her everyday life

A15 Identify and reduce risks and threats to a sustainable environment

A16 Extend the limits of human capabilities using technological enhancements

A17 Use and recognize various propaganda techniques

A18 Solve unique problems using the results of systematic analyses

A19 Choose everyday consumer products that utilize recent innovation and pass appropriate performance criteria

A20 Refine personal career interests through investigations of the diversity of manufacturing, research, service, and invention processes

Subunit: Applications for Science Learning (continued)

Competencies:

A21 Predict and investigate the working of toys and tools while controlling and manipulating variables (e.g., friction, gravity, forces)

A22 Write, follow, modify, and extend instructions (e.g., equations, algorithms, formulas, flow diagrams, illustrations)

A23 Create products, make inferences, and draw conclusions using databases, spreadsheets, and other technologies

A24 Predict various scenarios and propose solutions to community issues using scientific information (e.g., actuarial tables, census data, topographic maps, incidence data, climatic data)

A25 Use scientific evidence to consider options and formulate positions about the health and safety of others and him/herself

A26 Search for, use, create, and store objects and information using various strategies and methods of organization and access

A27 Research and write environmental impact statements of his/her own design

A28 Compare school-based science perspectives with those gained through cutting-edge technological applications

A29 Design management plans for natural and human-altered environments (e.g., woodlots, patios, lots, lawns, farmlands, forests)

A30 Refine personal career interests

A31 Promote public awareness of the interaction of technology with social i issues

A32 Advocate and propose courses of action for local and global scientific issues using global networks

A33 Use appropriate technologies to prepare and present the findings of investigations incorporating tables, graphs, diagrams, and text

A34 Make informed consumer choices by evaluating and prioritizing information, evidence, and strategies

A35 Develop an informed point-of-view that allows for validation or refutation of the scientific statements and claims of advocated before pursuing courses of action (e.g., contributing support, signing petitions, casting votes)

A36 Differentiate between observations and inferences in the exploration of evidence related to personal, scientific, and community issues

A37 Develop and write environmental impact and safety and hygiene management plans

A38 Use technology to collect, analyze, and communicate information (e.g., electronic networks, desktop publishing, remote sensing, graphing calculators, satellite telemetry, and others)

A39 Design, construct, and market inventions

Unit: Technology Literacy

NOTE: Over 500 Ohio business, industry, and labor representatives examined, altered, and then verified the content for this unit during the TCP Process. The original content was extracted from the Report of the Task Force on Technology Competence—Learner Goals for All Minnesotans, published by the Minnesota State Council on Vocational Technical Education. The Technology Literacy unit forms a critical link between all teachers and stresses the importance of technological impact on teaching and learning. [See "The TCP Process" for more information.]

Competencies:

T1 Demonstrate a systems view of technology based on the interdependence of social, political, economic, and ecological systems
T2 Assess the career, family, and personal development implications of technological change
T3 Demonstrate continuous learning via technology
T4 Demonstrate global appreciation for technology's potential effects on cultures, geographic areas, and the environment
T5 Apply historical perspective on technology to the development and use of new technologies
T6 Apply diverse technologies to store, access, process, create, and communicate information needed to solve problems
T7 Apply legal principles and ethical conduct to the use of technology
T8 Demonstrate competency in mathematics, science, social sciences, communication, and computer skills through the analysis, design, and evaluation of technological systems
T9 Analyze the potential of alternative technological systems to solve problems and/or to extend human capabilities
T10 Use a variety of tools, materials, and equipment in solving problems and extending human capabilities
T11 Assess risks and benefits of technological developments from an ecological, economic, social, and political perspective
T12 Value human diversity as part of a team in suggesting, designing, and testing solutions to technological problems

Unit: Employability Skills

Competency: **Develop a career plan**

Competency Builders:

Identify current interests and aptitudes
Identify common barriers to employment
Describe strategies to overcome employment barriers
Locate resources for finding employment
Research job trends
Identify career options
Identify advantages and disadvantages of career options (in addition to other than monetary)
Identify job requirements
Investigate education/training opportunities
Evaluate personal strengths and weaknesses

Competency: Prepare for employment

Competency Builders:

Identify traditional and non-traditional employment sources
Identify present and future employment opportunities (by geographic location)
Research job opportunities, including non-traditional careers
Compare salary ranges and benefit packages
Compile occupational profile
Identify rights and responsibilities of equal employment opportunity laws
Design resume and cover letter
Target resume
Secure references
Investigate generic and specific employment tests (e.g., civil service exam; drug screening)
Use follow-up techniques to enhance employment potential
Demonstrate legible written communication skills using correct grammar, spelling, punctuation, and concise wording
Describe methods for handling illegal questions on job application forms and during interviews
Write letter of application
Research prospective employer and services performed
Explain critical importance of personal appearance, hygiene, and demeanor
Interpret job description
Demonstrate appropriate interview question and answer techniques
Demonstrate methods for handling difficult interview questions
Evaluate job offers
Write letter of acceptance
Write letter of declination
Demonstrate good listening skills
Ask for the job tactfully
Participate in extracurricular activities (e.g., student government, community projects,)

Competency: Evaluate the importance of self-esteem as an employability skill

Competency Builders:

Identify factors that affect self-esteem
Compare effects of low self-esteem and high self-esteem
Identify strategies to promote positive self-esteem

Competency: Demonstrate job retention skills

Competency Builders:

Identify employer expectations regarding job performance, work habits, attitudes, personal appearance, and hygiene
Exhibit appropriate work habits and attitude
Demonstrate ability to set priorities
Identify behaviors to establish successful working relationships
Identify alternatives for dealing with harassment, bias, and discrimination based on race, color, national origin, sex, religion, handicap, or age
Identify opportunities for advancement
List reasons for termination
List consequences of being absent frequently from job
List consequences of frequently arriving late for work
Demonstrate interpersonal relations skills (i.e., verbal and written)
Demonstrate negotiation skills
Demonstrate teamwork
Follow chain-of-command
Exhibit appropriate job dedication

Competency: Demonstrate knowledge of work ethic

Competency Builders:

Define work ethic
Identify factors that influence work ethic
Differentiate law and ethics
Describe how personal values are reflected in work ethic
Describe how interactions in the workplace affect personal work ethic
Describe how life changes affect personal work ethic

Competency: Exhibit appropriate work ethic

Competency Builders:

Use time-management techniques
Avoid personal activity during work hours
Attend work as scheduled
Adhere to company and/or governmental policies, procedures, rules, and regulations
Exercise confidentiality
Demonstrate appropriate human relations skills
Adhere to rules of conduct
Accept constructive criticism
Offer constructive criticism
Take pride in work
Resolve conflict
Manage stress
Avoid sexual connotations and harassment
Adjust to changes in the workplace
Demonstrate punctuality
Assume responsibility for personal decisions and actions
Take responsibility for assignments
Follow chain-of-command

Competency: Apply decision-making techniques

Competency Builders:

Identify decision to be made
Identify ownership of decision to be made
Identify possible alternatives and their consequences
Make decisions based on facts, legality, ethics, goals, and/or culture
Apply time factor(s)
Present decision to be implemented
Evaluate decision made
Take responsibility for decision

Competency: Apply problem-solving techniques

Competency Builders:

Identify problem
Select appropriate problem solving tools/techniques
Identify root problem cause(s)
Track root problem cause(s)
Identify possible solutions and their consequences (e.g., long term, short term, crisis)
Use resources to explore possible solutions to problem
Contrast advantages and disadvantages of each solution
Identify appropriate action
Evaluate results
Identify post-preventive action

Competency: Exhibit characteristics for job advancement

Competency Builders:

Display positive attitude
Demonstrate knowledge of position
Perform quality work
Adapt to changing situations and technology
Demonstrate capability/responsibility for different positions
Identify characteristics of effective leaders
Identify opportunities for leadership in work place/community
Demonstrate initiative to affect change in workplace
Participate in continuing education/training program
Responds appropriately to criticism from employer, supervisor, or other employees
Exhibit awareness of corporate culture
Prepare for job setbacks
Exhibit continual growth based on performance evaluation
Set realistic goals

Unit: Professionalism

Competency: Project professional image

Competency Builders:

Define professionalism
Exhibit professional appearance
Exhibit professional manners
Project professional attitude
Identify individuals' vital role in organization
Exhibit proper etiquette in professionally-related situations

Competency: Achieve individual and professional goals

Competency Builders:

Set flexible, realistic, and measurable goals
Identify potential barriers to achieving goals
Identify strategies for addressing barriers to goal achievement
Breakdown long-term goals into short-term goals
Prioritize goals
Commit to goals
Adjust goals
Obtain support for goals
Reward goal achievement

Competency: Manage personal finances

Competency Builders:

Explain need for personal management records
Balance checkbook
Identify tax obligations
Analyze how credit affects financial security
Compare types and methods of investments
Compare types and methods of borrowing
Compare types and methods of insurance
Compare types of retirement options/plans
Identify discriminatory vs. non-discriminatory expenditures

Competency: Support community well-being

Competency Builders:

Identify environmental, educational, and social issues
Participate in social and/or community activities

Competency: Achieve organizational goals

Competency Builders:

Evaluate personal goals in relation to organizational goals
Monitor progress by evaluating feedback
List responsibilities in relation to organization goals
Accomplish assigned tasks
Exercise responsibility in relation to organizational goals
Set appropriate personal performance standards
Communicate goals with supervisor and peers
Demonstrate knowledge of products and services
Promote organizational image and mission

Competency: Demonstrate positive relations in the workplace

Competency Builders:

Identify personality types of self and other
Identify various management styles
Support employer expectations
Support employer decisions
Accept constructive criticism
Give constructive feedback
Adapt to changes in workplace
List factors to consider before resigning
Write letter of resignation

Competency: Manage stressful situations

Competency Builders:

Accept stress as part of daily life
Identify personal and professional factors contributing to stress
Describe physical and emotional responses to stress
Evaluate positive and negative effects of stress on productivity
Identify strategies for reducing stress
Implement strategies to manage stress
Create strategies for developing and maintaining support systems

Competency: Analyze effects of family on work and work on family

Competency Builders:

Identify how family values, goals, and priorities are reflected in work place
Identify responsibilities and rewards associated with paid and non-paid work
Identify responsibilities and rewards associated with families
Explain how family responsibilities can conflict with work
Explain how work can conflict with family responsibilities
Explain how work-related stress can affect families
Explain how family-related stress can affect work
Identify family support systems and resources
Identify work-related support systems and resources
Communicate with family regarding work

Competency: Apply lifelong learning skills

Competency Builders:

Define lifelong learning
Identify factors that cause need for lifelong learning
Analyze effects of change
Identify reasons why goals change
Describe importance of flexibility and adaptability
Evaluate need for continuing education/training

Competency: Manage professional development

Competency Builders:

Identify career opportunities
Modify career plan
Participate in continuing education/training opportunities
Document continuing education/training
Read profession-related manuals, technical journals, and periodicals
Attend meetings, workshops, seminars, conferences, and demonstrations
Participate in professional organizations
Build personal/professional mentor relationship
Build personal/professional support system
Build professional network
Strengthen communication skills
Strengthen leadership skills
Strengthen management skills

Unit: Teamwork

Competency: Demonstrate knowledge of teamwork

Competency Builders:

Define empowerment
Differentiate work groups and teams
Identify conditions essential to teamwork (e.g., brainstorming)
Explain influence of culture (e.g., corporate, community) on teamwork
Identify appropriate situations for using teams
Define team structures (e.g., cross functional, quality improvement, task force, quality circles)
Identify team building concepts
Describe characteristics and dynamics of teams
Identify characteristics of effective team leaders and members
Identify responsibilities of a valuable team member
Identify methods of involving each member of a team
Explain how individuals from various backgrounds contribute to work-related situations (e.g., technical training, cultural heritage)
Explain the purpose of facilitators
Define consensus
Define reward/recognition system

Competency: Demonstrate teamwork

Competency Builders:

Identify purpose of team and intended goal (include time frames)
Structure team around purpose
Define responsibilities of team members
Contribute to efficiency and success of team
Work toward individual and team milestones
Analyze results of team project
Facilitate a team meeting
Assist team member(s) with problem
Monitor time frame
Stress continuous improvement
Accept failure as part of learning

Competency: Use teamwork to solve problems

Competency Builders:

Identify appropriate situations for using teams
Use problem-solving process in a team setting
Identify quality management processes/techniques
Identify quality assurance processes/techniques
Prepare presentation

Competency: Conduct team meetings

Competency Builders:

Plan agenda
Schedule meeting and location
Invite appropriate personnel
Solicit outside speakers as needed
Assign someone to take minutes
Facilitate introductions
Invite questions and comments and group participation
Focus team on agenda items
Assign appropriate action, time frame and accountability to tasks
Monitor time
Close meeting on time
Publish minutes in timely manner
Set ground rules
Avoid placing individual agendas above the group's agenda

Unit: Quality Assurance

Competency: **Demonstrate knowledge of quality assurance**

Competency Builders:

Explain the historical evolution of quality assurance (e.g., Deming, ISO 9000)
Explain changes brought about by quality leaders in the world
Explain the ISO 9000 process
Define quality terms
Define quality functions
Identify features of quality planning
Describe control devices used in functional areas (e.g., SPC, equipment)
Explain the relationship among organizational structures, policies, procedures, and quality assurance
Explain importance of internal and external customers
Identify internal and external customers
Describe successful efforts by industry to improve quality and/or reduce costs
Differentiate prevention and detection
Differentiate variable and attribute data
Identify types of coontrol charts
Explain how statistical techniques are tools used to control quality (e.g., SPC, DOE, CR)

Competency: Demonstrate knowledge of quality cost implications

Competency Builders:

Identify cost/quality objectives
Classify costs (i.e., direct and indirect, fixed and variable, methods and standards)
Classify quality costs (i.e., prevention, evaluation, pre-delivery failure post-delivery failure)
Define produce liability
Interpret quality cost reports
Explain consumerism and liability prevention
Define safety terms of product
Identify safety responsibility within organization
Define contracts and torts
Differentiate express and implied warranty
Differentiate warranty and product liability
Explain how warranties are part of contract law
List questions that would need answering in liability claim

Competency: Demonstrate knowledge of engineering a quality product

Competency Builders:

Associate customer satisfaction with product characteristics (e.g., usefulness, price, operation, life, reliability, safety, cost of operation)
Define manufacturability
Identify steps in product design (e.g., brainstorming, thumbnail sketches, rendering)
Define reliability factors (e.g., cost, human, producibility)
Identify ways reliability is achieved (e.g., maintainability, good design, design simplification, design redundancy)
Explain the relationship of maintainability to reliability
Define failure
Explain the role of testing and reliability
Define value engineering
Define quality objectives
Identify cost components as they relate to quality objectives
Classify quality costs (i.e. preventive, evaluation, pre-delivery failures, post delivery failures)
Describe predictive maintenance

Competency: **Explain importance of interdepartmental relationships to quality assurance**

Competency Builders:

Explain need for everyone's commitment in assuring quality
Explain phrase "Everyone is a customer/supplier"
Define quality improvement team models
Explain the importance of top management's support of quality
Explain project selection
Explain project implementation
Explain project evaluation
Explain continuing improvement
Describe future trend of experiment design
Describe future trend of predictive maintenance

Competency: **Manipulate quality cost data**

Competency Builders:

Develop quality cost data
Translate cost reports
Graph quality cost data (e.g., pareto)

Competency: **Manipulate cost control data**

Competency Builders:

Develop cost control data
Analyze cost control reports
Provide cost control data
Provide advice on "Make or Buy" decisions (including economical lot size decisions)

Competency: Demonstrate knowledge of basic statistics

Competency Builders:

Describe data collection methods
Collect data
Organize data by flow chart
Interpret data by cause and effect diagrams
Define nominal, ordinal, interval, and ratio data
Define mean, median, and mode
Explain significance of standard deviation
Explain normal distribution

Competency: Demonstrate knowledge of scattergrams

Competency Builders:

Construct scattergram
Interpret for positive, negative, or no correlation between X and Y variables
Test for significance between one and five percent
Explain regression analysis

Competency: Demonstrate knowledge of probability theory

Competency Builders:

Define classical probability
Define empirical probability
Calculate probability for outcomes

Competency: Demonstrate knowledge of precontrol

Competency Builders:

Explain uses of precontrol
Calculate precontrol limits
Explain significance of the limits
Plot values on a precontrol chart
Explain "out-of-control" situation
Make decisions on green, yellow and red conditions

Competency: Demonstrate knowledge of process capability

Competency Builders:

Use X, R, USL, and LSL to determine process capability (upper and lower specification limits)
Calculate estimated process standard deviation
Plot right hand and left hand tail of process variation
Compute Z value for percent of probable defect for process
Calculate C_{PK} values that describe process capability
Describe skewed distributions
List probable causes of skewed distribution

Competency: Use quality control charts

Competency Builders:

Identify operational definitions for attribute criteria
Interpret histogram
Interpret scattergrams
Interpret NP chart
Interpret P chart
Interpret flowchart
Interpret cause-and-effect diagram
Construct P (percentage defective) chart for attributes
Plot control limits of P chart and data points
Check chart for out-of-control conditions
Construct an NP (number defective) chart with control limits and data
Construct C (count of defects) and U (number of defects per unit) charts
Check data on C and U charts
Construct flowchart
Construct cause-and-effect chart

Competency: Interpret $\bar{X}$ and R charts

Competency Builders:

Plot percentages for normal distribution
Test distribution for normality
Explain difference between common cause and special cause
Define an "in-control" process
Explain significance of an out-of-control point on $\bar{X}$ or R chart
Identify patterns and trends on control chart
Identify run up and run down
Test for middle third on control chart
Explain significance of middle third on control chart
Explain Rule of Sevens

Competency: Construct $\bar{X}$ and R charts

Competency Builders:

Arrange data into statistical sub-groups
Explain importance of random sampling
Compute $\bar{X}$ (i.e., average of values) and R (i.e., range of values in subgroup) within sample
Plot in $\bar{X}$ and R on chart
Construct control chart with $\bar{\bar{X}}$ (grand average) and R (average range) calculated
Calculate upper and lower control limits for $\bar{X}$-chart
Calculate upper and lower control limits for R-chart

Competency: Conduct process improvement studies

Competency Builders:

Analyze production methods and processes applying statistical process improvement techniques (e.g., SPC, C_{PK})
Identify appropriate statistical techniques for study (e.g., T-tests, F-test, capability, DOEX)
Identify major steps in conducting a study
Define "report" for a study (e.g., goal, objective, study conduct, results, conclusions, discussions)
Integrate results into the total system

Competency: Demonstrate knowledge of JIT

Competency Builders:

Define just-in-time concept (JIT)
Describe various production methodologies (e.g., standard cycle times, routings, standard quantities, multiple-machine tending)
Describe types of inventory control (e.g., Kanban)
Describe importance of flexibility
Differentiate product layout, process layout, fixed position layout, and cellular layout
Differentiate straight-line, U-shaped, S-shaped, convoluted and comb patterns
Describe advantages/disadvantages of layout and patterns
Explain importance of product protection, identification and storage
List methods of identifying products (e.g., labels, bar codes, radio frequency systems and magnetic strip systems)
Describe manual methods of storage and retrieval
Describe automated storage and retrieval systems (ASRS)
Describe automated guided vehicle moving systems (AGVS)

Competency: Apply JIT

Comptency Builders:

Maintain system for physical handling and movement of material in-process and in-storage
Monitor system of physical handling and movement of material in-process and in-storage
Maintain system for physical handling and movement of finished products
Monitor system of physical handling and movement of finished products
Write requests for deviation from specifications
Implement quality control and inspection standards and procedures
Write engineering change notices and rejection reports
Monitor reports of discrepancy or rejects during production process
Conduct quality tests under different environmental conditions

Competency: Demonstrate knowledge of inspection

Competency Builders:

Explain purpose of inspection
Describe scope of inspection
Explain purpose of incoming, ongoing, and final inspections
Explain early detection inspection
Explain how statistical process control (SPC) aids inspection
Define types of nonconformance
Define degrees of nonconformance
Define corrective action
Describe when to 100% inspect
Describe when to sample inspect
Describe methods of testing for material properties (e.g., harness, strength, chemical makeup, flaws, errors in tooling or setup)
Define rework, salvage, and scrap
Describe ethical decisions an inspector may make
Identify purposes of computer-automated inspection
Explain advantages and limitations of automated inspection
Explain disposition of non-conforming material
Explain basic foolproofing concept to build inspection into process (i.e., poka-yoke)
Use checksheets to organize and record inspection results

Competency: Inspect machinery, materials, and products

Competency Builders:

Identify critical material characteristics from specification(s) or drawing(s)
Perform capability studies for machinery and materials acceptance
Identify appropriate acceptance sampling plan
Conduct incoming materials inspection using sampling plan criteria
Identify critical in-process characteristics from specification(s) or drawing(s)
Demonstrate basic metrology skills
Conduct in-process inspection
Identify appropriate inspection reports and follow-up
Gauge R and R (reproducibility and repeatability)
Apply geometric tolerancing
Explain C = O (zero) acceptance plan
Interpret instructions in a control plan

Competency: **Demonstrate knowledge of nondestructive testing**

Competency Builders:

Describe purpose of nondestructive testing
Identify anomalies
Define defects and discontinuities
Identify factors contributing to defects and discontinuities
Describe ultrasonic testing
Describe advantages and limitations of ultrasonic testing
Describe industrial radiography
Compare use of wet and dry particles in magnetic particle inspection
Explain advantages and limitations of penetrant inspection
Describe microwave testing
Describe holographic inspection
Explain choice of most suitable nondestructive test method
Describe eddy-current testing

Unit: Technical Recording and Reporting

Competency: Demonstrate proficiency in technical recording

Competency Builders:

Describe various documentation procedures
Interpret specifications or drawings
Observe process
Ask open-ended questions
Record process (e.g., flowchart, step-by-step)
Identify parameters
Record accurate, truthful data
Maintain test logs
Compile cumulative reference notebook/record
Measure appropriate parameters
Draft preventive maintenance and calibration procedures

Competency: Demonstrate proficiency in technical reporting

Competency Builders:

Use data books and cross reference/technical manuals
Compose technical memoranda
Identify type of report or format needed
Use appropriate format
Compile relevant data
Design charts and graphs
Analyze data
Draw conclusions
Explain analytical methods used
Outline reports
Write reports
Present reports

Unit: Computer Literacy

Competency: Describe personal computer operations

Competency Builders:

Explain how data is stored in main computer memory
Explain how computer system executes program instruction
Explain computer storage capacity
Explain how data is represented
Describe data storage techniques
Identify types of memory

Competency: Explain information processing cycle

Competency Builders:

Define operating systems (e.g., DOS, OS/2, UNIX, MAC)
Describe computer languages and their use
Describe computer languages and their use
Describe computer languages and their use
Describe difference between data files and program files
Explain PC layout
Explain PC network layout
Explain mini/mainframe network layout
Differentiate hardware and software
Differentiate open from proprietary architecture

Competency: Operate computer hardware

Competency Builders:

Practice proper media handling techniques (e.g., magnetic fields, dust, liquids)
Identify hardware and its use
Use hardware (e.g., mouse, diskettes, drive, modems, touch screen, printers, digitizers, scanners, cables, protection devices)
Keyboard efficiently
Demonstrate basic care of hardware
Explain need for and application of security levels/procedures
Perform basic hardware troubleshooting
Explain hardware addressing techniques

Competency: Use software

Competency Builders:

Define software types and functions
Describe basic disk operations and care
Perform functions necessary to operate software
List advantages and disadvantages of integrated and dedicated software
Operate system software
Operate diagnostic software
Demonstrate basic proficiency in spreadsheet use
Demonstrate basic proficiency in word processing
Demonstrate basic proficiency in database use
Demonstrate basic proficiency in network use
Demonstrate basic proficiency of utility (e.g., WINDOWS, GUI)
Demonstrate basic proficiency in report writing
Demonstrate system commands
Differentiate ethical use/misuse of software
Describe bulletin boards/electronic mail
Apply security levels/procedures while handling sensitive data
Explain data compression techniques
Explain use and deletion of passwords

Unit: Workplace Safety

Competency: Apply general safety precautions

Competency Builders:

Identify local, state, and federal rules and regulations
Identify personal protective wear and equipment
Identify visual controls (e.g., monitors, read outs)
Identify auditory controls
Identify common sense housekeeping
Interpret hazardous materials notices on containers
Use personal protective wear and equipment
Apply workplace safety rules and procedures
Apply personal safety rules and procedures
Apply workplace organization (e.g., housekeeping)
Apply applicable electrical, mechanical, steam, hydraulic and (e.g., pneumatic safety rules and procedures)
Apply fire safety rules and procedures
Apply hazardous wastes rules and procedures
Apply first aid
Locate (MSDS)
Perform lockout and tagout
Recycle scrap metal, chips, shavings, coolants, solvents, trash, and waste materials
Apply common sense housekeeping
Use preventive maintenance checklists

Competency: Demonstrate knowledge of safety and workplace hazards

Competency Builders:

Describe corrective procedures for unsafe conditions
Identify types and potential level of workplace hazards (e.g., physical hazards, fire, chemicals, noise, ionizing radiation, ultraviolet, temperature extremes, ergonomics, biological hazards)
Identify safety materials/equipment (e.g., absorbant socks, oil dry)
Interpret Material Safety Data Sheets (MSDS)
Explain purpose(s) of OSHA and NIOSH
Explain purpose(s) of NEC and NFPA
Identify purpose of emergency evacuation routes, master switch and lockout locations, and safety color coding systems
Identify roles of industrial hygienists, safety professionals, occupational physicians, and occupational nurses
Describe methods of evaluating potential hazards (e.g., visual analysis)
Describe methods of correcting potential hazards
Describe various types of toxicity (e.g., chronic, immediate)
Identify need for reporting accidents
Explain precautions required when using toxic or flammable materials
Define confined space and related requirements
Explain how international directives relate to safety

Competency: Explain purpose of industrial pollution control systems

Competency Builders:

Describe types of air, water, solid waste, and noise pollution
Explain purpose of air pollution control systems
Explain purpose of water pollution control systems
Explain purpose of solid waste pollution control systems
Explain purpose of noise pollution control systems
Explain basic philosophy of "right to know" legislation
Explain purpose(s) of EPA
Identify "costs" of industrial pollution control (i.e., dollars vs. impact to environment)
Describe ethics of environmental issues

Competency: Demonstrate knowledge of ergonomics

Competency Builders:

Define ergonomics
Define risk factor
Define maximum permissible limit (MPL) and action limit (AL) for lifting
Define cumulative trauma disorder (CTD)
Identify susceptibility factors for CTD
Minimize extreme joint movement
Minimize use of excessive muscle force
Minimize repetitive tasks
Minimize mechanical stresses (e.g., sharp edges, heat, cold, hard surfaces, weights, vibration)
Minimize awkward body positions
Explain use of rest pauses
Explain need for mats and footrest for standing jobs
Explain need for appropriate working heights of chairs, stools, workbenches, equipment
Explain need for adequate lighting
Explain use of anthropometric (i.e., centering one's view of everything around man) design

Unit: Drafting Technology

Competency: Apply basic drafting skills

Competency Builders:

Use drafting equipment, measuring scales, drawing media, drafting instruments and consumable materials, blueprint machine
Identify line styles, weights (alphabet of lines)
Select proper drawing scale, introduction to different types
Prepare title blocks and other drafting formats
Apply freehand and other lettering techniques
Prepare multi-view drawings
Prepare multi-view sketches
Prepare orthographic views
Prepare change control block
Describe change control block/revision block
Measure angles
Draw horizontal, vertical, angular, parallel, and perpendicular lines
Transfer an angle
Construct tangent lines (to arcs) and tangent arcs (to arcs)
Bisect angles and arcs
Bisect lines
Divide lines
Construct three-point circle
Construct regular hexagon, pentagon, and octagon
Reproduce a drawing
Prepare single-view drawings
Prepare dimension drawings
Interpret notes and dimensions to determine part
Draw arcs, circles, and conics
Transfer measurements

Competency: Apply intermediate drafting skills

Competency Builders:

Describe types of blueprints and their applications
Apply isometric, oblique and perspective sketching techniques
Prepare isometric, oblique and perspective sketches
Prepare sectional views
Prepare auxiliary views
Identify ANSI symbols
Prepare views of drilled and tapped holes, counterbores, countersinks
Apply systems drafting techniques
Identify a bill of materials
Dimension drawings using ANSIy14.5 standards
Describe purpose of auxiliary and sectional views

Competency: Apply advanced drafting skills

Competency Builders:

Interpret reports and specifications
Prepare pictorial drawings
Prepare schematics
Draw conics
Interpret basic pneumatic/hydraulic standard and symbols
Interpret various drawings (e.g., welding, casting, stamping, forging, civil, maps, pattern shop)

Competency: Interpret basic prints

Competency Builders:

Visualize object from drawing
Interpret orthographic projections
Interpret isometric views
Interpret sectional views
Interpret detail and assembly drawings
Interpret dimensions
Interpret tolerances

Competency: Interpret intermediate prints

Competency Builders:

Interpret screw thread specifications
Identify structural steel shapes
Interpret special symbols
Interpret electrical, pneumatic/hydraulic drawings
Interpret schematics

Competency: Interpret advanced prints

Competency Builders:

Interpret GD&T characteristic symbols
Interpret GD&T supplementary symbols

Competency: **Demonstrate knowledge of basic geometric dimensioning and tolerancing**

Competency Builders:

Identify geometric characteristics and symbols (i.e., flatness, straightness, roundness, cylindricity, profile of line, profile of surface, perpendicularly, angularity, parallelism, circular, runout, total indicated runout, position, concentricity, and symmetry)
Define maximum material condition
Define least material condition
Define regardless of feature size condition
Describe feature control blocks
Describe datum surfaces and targets
Define flatness (pitch)
Define straightness (yaw)
Define roundness
Define cylindrically
Define profile of line
Define profile of surface
Define perpendicularity
Define angularity
Define parallelism
Define circular runout
Define total runout
Define true position concept to determine tolerance for location of holes in mating parts

Competency: **Convert dimensions and tolerances**

Competency Builders:

Convert dimensions and tolerances from English units to metric units
Convert dimensions and tolerances from metric units to English units

Competency: Apply revision control process

Competency Builders:

Apply drawing balloons
Apply documentation (including project filing, back-up material, tracking process)
Apply change control block
Apply revision levels

Competency: Demonstrate dimensioning techniques

Competency Builders:

Construct arrowheads using various styles/disciplines
Apply symbols for surface and texture control
Add labels/notes to drawing
Interpret decimal tolerance dimensions
Dimension arcs
Dimension angles
Dimension curves
Dimension rounded-end shapes
Dimension spherical objects
Dimension cylindrical objects
Dimension cones, pyramids, and prisms
Dimension features on circular center line
Dimension theoretical point of intersection
Dimension object using rectangular coordinate system
Dimension object using polar coordinate system
Dimension object using tabular coordinate system
Dimension object using ordinate dimensioning system

Competency: Apply geometric dimensioning and tolerancing

Competency Builders:

Interpret decimal tolerance dimensions
Calculate clearance fit tolerances of mating parts
Dimension clearance fit tolerances of mating parts
Calculate interference fit tolerances of mating parts
Dimension interference fit tolerances of mating parts
Calculate tolerances to mating parts using standard fit tables
Assign tolerances to mating parts using standard fit tables
Apply positional and form tolerancing symbols
Apply symbols for true position
Apply symbols for maximum material control and regardless of feature size
Calculate effects of dimensional stack-up
Calculate transitional fit tolerances
Dimension transitional fit tolerances

Competency: Perform basic physical layouts

Competency Builders:

Use inside diameter (ID), outside diameter (OD), and hermaphrodite calipers
Layout with combination square
Layout with scriber, divider and trammel
Use surface plate
Use surface gage
Use layout fluid
Use V-blocks
Use clamps
Use angle plate
Use parallels
Use punches
Use transfer method tools
Use layout hammer
Use machinist's square
Use universal bevel protractor
Use machinist's scale

Competency: Prepare mechanical drawings

Competency Builders:

Interpret basic mechanical standards and symbols
Prepare assembly drawings
Prepare welding drawings
Prepare bearing drawings
Prepare casting drawings
Prepare forging drawings
Prepare tool drawings
Prepare molding diagrams
Prepare drawings with special processed holes
Prepare stamping drawings
Prepare numerical control drawings/instructions
Prepare installation drawings
Prepare purchase part drawings
Prepare approval drawings

Competency: Prepare advanced mechanical drawings

Competency Builders:

Resolve problems by descriptive geometry and revolutions
Use precision dimensioning to include geometric characters
Use precision measuring instruments (e.g., calipers)
Prepare fastener drawings
Prepare cam drawings
Prepare gear drawings
Prepare spring drawings
Prepare pulley and chain drive drawings

Unit: CADD Fundamentals

Competency: Demonstrate basic use of computer operating system

Competency Builders:

Create ASCII text files with a text editor
Explain rules for naming files and directories
Manage files
Create directories
Remove directories
Change directories
Copy files
Rename files
Erase files
Format diskettes
Label diskettes
Explain the syntax of operating system commands
Use wildcards in operating system commands

Competency: Operate a CADD system

Competency Builders:

Execute CADD system
Use keyboard input
Use screen and tablet menus
Use other input devices (e.g., scanner, digitizer)
Create scaled plots
Operate a pen plotter
Operate a printer-plotter (i.e., laser plotter)
Access on-line help for commands
Use file conversion
Use data transfer

Competency: Select entities for action

Competency Builders:

Add or remove entities separately
Add or remove entities using a window
Add or remove entities with a crossing-box
Select entities using a fence
Select entities by other methods (e.g., last, previous, type, all, etc.)

Competency: Create 2-D orthographic drawings

Competency Builders:

Create primitive drawing entities
Draw utilizing absolute Cartesian coordinates
Draw utilizing relative Cartesian coordinates
Draw utilizing polar coordinates
Draw using construction aides (e.g., snaps, grid, snap, etc.)
Change drawing attributes
Edit drawing entity properties (e.g., color, layer, thickness, linetype)
Construct drawing entities (e.g., offset, timer, extend, break, mirror, etc.)
Edit drawing entities (e.g., offset, trim, extend, break, mirror, etc.)
Set system variables (e.g., units, scale)
Use system variables
Create layers
Name layers
Manipulate layers
Save files
Create back-ups
Create hatches, patterns, symbols
Recall drawing templates/blocks

Competency: Annotate orthographic drawings

Competency Builders:

Create text styles
Edit text styles
Select text styles
Apply notes

Competency: Dimension orthographic drawings

Competency Builders:

Create dimensions
Edit text
Control dimension variables/models

Competency: Control display

Competency Builders:

Apply view control while drawing (e.g., zoom and pan)
Control view resolution (e.g., viewers)
Save views
Display views

Competency: Extract entity and drawing information

Competency Builders:

Measure distances
Measure areas
Identify locations
List entity characteristics (e.g., length, size, location, properties, etc.)

Unit: Equipment Maintenance

Competency: Perform housekeeping

Competency Builders:

Dispose of scrap metal chips, shavings, trash and waste
Clean work area
Store hand tools, cutters, fixtures, jigs and attachments
Store grinding wheels
Follow tool crib procedures
Inspect machine guards
Replace or adjust machine guards
Report problems to supervisor

Competency: Perform recordkeeping

Competency Builders:

Explain reasons for keeping maintenance records
Explain reasons for keeping cost records
Complete work order
Complete internal requisition
Complete external requisition
Complete time cards
Complete job status reports
Complete equipment failure reports
Record preventive maintenance activities
Record repair activities
Read job orders and process sheets
Locate tooling and set up information
File reports
Prepare new/replacement equipment recommendations

Competency: Inspect machine systems

Competency Builders:

Explain planned maintenance
Explain predictive maintenance measures
Explain preventive maintenance measures (e.g., lubrication)
Log machine histories
Explain machine system(s) calibration
Inspect linkages and lever mechanisms
Inspect drive couplings
Inspect clutches
Inspect roller ball bearings
Inspect safety systems
Analyze system failure
Make minor adjustments/repairs
Coordinate maintenance services

Competency: Perform machine maintenance

Competency Builders:

Use operator's and manufacturer's manuals
Operate individual machines
Diagnose malfunctions
Apply lockout/tagout procedure
Disassemble defective section
Clean equipment
Lubricate equipment
Check equipment for wear and alignment
Repair or replace defective parts
Test machine for performance
Make minor adjustments to equipment
Prepare planned maintenance schedules
Explain breakdown maintenance

Competency: Maintain hand tools

Competency Builders:

Demonstrate use and care of measuring devices (e.g., rules, tapes, calipers, micrometers, multimeter, thermometer, and coordinate measuring system)
Demonstrate use and care of equipment used to bend and assemble rigid conduit and tubing
Demonstrate use and care of common hand tools
Demonstrate use and care of wood working tools (e.g., saws, planes, drills, hammers)
Demonstrate use and care of sheet metal tools (e.g., sheet metal gauges, hand seamers, soldering irons)
Demonstrate use and care of ropes, slings, pullers, and block and tackle
Demonstrate proper metal working bench skills (including use of vices, hacksaws, files, tapes, dies, and reamers)
Demonstrate use and care of pipe clearing equipment

Competency: Maintain portable power tools

Competency Builders:

Demonstrate use and care of light-duty and heavy-duty drills
Demonstrate use and care of electric hammers
Demonstrate use and care of pneumatic drills and hammers
Demonstrate use and care of power screwdrivers and impact wrenches
Demonstrate use and care of linear motion saws
Demonstrate use and care of circular saws
Demonstrate use and care of routers and planes
Demonstrate use and care of belt, pad and disc sanders
Demonstrate use and care of grinders and shears
Demonstrate use and care of explosive actuated tools
Demonstrate use and care of electric lifts

Competency: **Maintain stationary equipment**

Competency Builders:

Demonstrate use and care of mechanical presses
Demonstrate use and care of hydraulic presses
Demonstrate use and care of drill presses
Demonstrate use and care of bench grinders
Demonstrate use and care of power saws (e.g., hack, cut-off, chop, band, jig, and table)
Demonstrate use and care of band saws
Demonstrate use and care of pipe threaders
Demonstrate use and care of metal brakes
Demonstrate use and care of power shears

Unit: Precision Machining

Competency: **Perform prerequisite machining skills**

Competency Builders:

Demonstrate maintenance of immediate work area, machinery, tools and gages
Demonstrate proficiency in interpreting prints/drawings
Demonstrate proficiency in planning work sequence/set up
Follow safety rules and regulations for each machine

Competency: **Analyze machine shop jobs**

Competency Builders:

Identify sequence of work on specified project(s)
Identify tolerances and finishes on specified project(s)
Identify variables that effect job efficiency (e.g., speeds, feeds)
Use Machinery Handbook
Identify causes of workpiece defects

Competency: **Achieve machine shop job standards**

Competency Builders:

Write machine shop job procedure
Complete machine shop job status report(s)
Analyze machine shop job evaluation data

Competency: Perform bench operations

Competency Builders:

Use measuring instruments and hand tools
Deburr workpiece
Lay out workpiece
Drill hole
Hand tap hole
Cut threads with die
Apply basic metallurgy knowledge

Competency: Operate metal cutting saw

Competency Builders:

Identify types and uses
Identify proper cutting fluids
Transfer dimensions from blueprint
Clean metal cutting saw
Lubricate metal cutting saw
Install guides
Adjust guides
Select proper blades
Weld saw blade
Install saw blade
Select speeds and feeds
Cut metal
Deburr workpiece
Apply basic metallurgy knowledge

Competency: Operate drill press

Competency Builders:

Clean drill press
Lubricate drill press
Identify proper cutting fluid
Mount part
Select proper bit, speed, and feed
Demonstrate proper bit sharpening techniques
Drill part
Countersink
Tap hole
Apply basic metallurgy knowledge

Competency: Operate tool and cutter grinding machine

Competency Builders:

Identify parts of machine
Identify proper cutting fluids
Identify causes of workpiece defects
Select proper wheels and work holding devices (e.g., superabrasives)
Perform truing operations
Perform dressing operations
Perform forming operations
Select proper speeds and feeds
Sharpen end mill
Sharpen horizontal milling cutter
Sharpen drills and countersinks
Apply basic metallurgy knowledge

Competency: Operate pedestal grinder

Competency Builders:

Clean pedestal grinder
Lubricate pedestal grinder
Identify proper wheel
Identify proper coolant
Check wheel for defects
Mount wheel
Position guard and rest
Dress wheel
Sharpen drill bit
Apply basic metallurgy knowledge

Competency: Operate lathe

Competency Builders:

Clean and lubricate lathe
Identify proper cutting fluid
Identify proper tools and holders
Sharpen tools properly
Mount workpiece
Use dial indicator
Position guards
Select feed(s) and speed(s)
Face workpiece
Turn shaft
Turn taper
Knurl workpiece
Cut off workpiece
Deburr
Demonstrate use of a 4-jaw chuck
Center drill hole
Cut threads (inside and outside)
Turn inside bore
Demonstrate use of steady rest
Demonstrate use of centers
Apply basic metallurgy knowledge

Competency: Operate milling machine

Competency Builders:

Clean milling machine
Lubricate milling machine
Identify proper cutting fluid
Select proper tool
Select proper feeds and speeds
Type of cut (e.g., climb, std.)
Mount workpiece
Mount tool
Mill surface
Mill keyway
Drill workpiece
Bore with milling machine
Mill angle
Apply basic metallurgy knowledge

Competency: Operate surface grinder

Competency Builders:

Clean surface grinder
Lubricate surface grinder
Identify proper cutting fluid
Select proper wheel
Select proper speeds and feeds
Check wheel for defects
Mount wheel
Position guard
Dress wheel
Identify proper mounting techniques
Mount workpiece
Set surface grinder
Apply basic metallurgy knowledge

Competency: Select materials for job

Competency Builders:

Interpret color codes, numbering systems, and classification systems of materials (i.e., ANSI, SAE)
Identify metals using spark test
Identify metals using variety of tests
Identify materials
Apply basic metallurgy knowledge

Competency: Perform heat treatment and testing of metals

Competency Builders:

Test hardness of metals
Perform non-destructive testing
Perform destructive testing
Harden metals to job specifications
Temper metals to job specifications
Anneal metals to job specifications
Normalize metals to job specifications
Case harden metals to job specifications

Competency: Explain nontraditional machining processes

Competency Builders:

Describe principles of chemical etching
List applications of chemical etching
List advantages/disadvantages of chemical etching
Describe principles of photochemical etching
List applications of photochemical etching
List advantages/disadvantages of photochemical etching
Describe electrical-discharge machining (EDM)
List applications of EDM
Differentiate between EDM and wire EDM
List applications for wire EDM
Describe principles of electrochemical machining
List applications of electrochemical machining
List advantages/disadvantages of electrochemical machining
Describe principles of water jet cutting
List applications of water jet cutting
Describe principles of torch cutting
List applications of torch cutting
Describe principles of laser cutting
List applications of laser cutting
List advantages/disadvantages of laser cutting
Describe shot peen
Describe media finish
Describe glass bead
Describe principles of laser welding

Competency: Perform precision layouts

Competency Builders:

Identify appropriate tools for measuring
Describe precision, accuracy, tolerance, reliability, and discrimination
Distinguish between precision and semiprecision measuring
Define standard stock dimensions and tolerances
Demonstrate knowledge of different units of measure (metric, standard, inches, etc.)
Describe common measurement errors and correction procedures
Calibrate measuring machines and devices
Demonstrate care of measuring instruments
Demonstrate use of rule
Demonstrate use of tape
Demonstrate use of pi tape
Demonstrate use of combination square
Demonstrate use of calipers
Demonstrate use of micrometers (inside and out)
Demonstrate use of dial indicators
Demonstrate use of sine bar
Demonstrate use of gauges (e.g., dial bore, dial snaps)
Demonstrate use of surface plate
Demonstrate use of protractor
Explain use of profilometer
Demonstrate use of thermometer
Demonstrate use of dividers
Demonstrate basic use of gauge blocks
Demonstrate use of threading specs
Explain use of optical comparitor
Explain use of digital instruments
Explain use of electronic gauging equipment
Explain use of data acquisition equipment
Explain operation of manual coordinate measuring machine (CMM)
Explain use and application of laser alignment/measurement

Unit: Computerized Numerical Control (CNC)

Competency: Demonstrate knowledge of CNC

Competency Builders:

Define numerical control (NC) and computerized numerical control (CNC)
Differentiate NC and CNC
Describe closed loop, open loop, and adaptive controls
Define point to point systems
Identify tool movement of point to point systems
Define continuous path systems
Identify tool movements of continuous path systems
Identify data input mediums
Explain the purpose of the post-processor
Define canned cycles
Identify computer memory types
Identify information stored relative to computer memory types
Differentiate hardware and software
Differentiate among CNC, machining centers, and robots
List advantages/disadvantages of CNC machining centers
Explain direct numerical control (DNC)

Competency: Perform preventive maintenance

Competency Builders:

Follow proper safety procedures
Clean CNC equipment
Lubricate CNC equipment
Check CNC equipment for wear and alignment

Competency: Apply CNC operations

Competency Builders:

Identify parts of the machine
Apply basic programming skills to a turning and a milling operation
Select proper work holders
Select proper cutting tools
Set machine parts to drawing tolerances
Use CAD/CAM for part program development

Competency: Prepare CNC program

Competency Builders:

Write a program manually in word address format
Write a program off line
Write a program manually in conversational program
Generate a program using CAD/CAM package
Program machine using manual data input (MDI) process

Competency: Program CNC operations

Competency Builders:

Apply ANSI drawing standards
Apply process planning from drawing to finished product
Analyze workpiece
Contrast differences in computer-assisted programming
Perform basic trigonometric computations
Perform special perception mathematical computations
Set chip load, feed rates and surface feet per minute limitations
Turn intersection points into segments (i.e., defined in terms of points, lines, and circles)
Debug program

Competency: **Load machine**

Competency Builders:

Load program from MDI and off-line programming station
Prepare work-holding device
Mount work-holding device
Secure workpiece
Set up reference and clearance points
Set up tooling
Select proper lubrication/coolant

Competency: **Operate CNC machine**

Competency Builders:

Load raw material
Start cycle
Monitor work in-process
Edit CNC programs
Demonstrate ability to halt running program
Apply proper safety procedures
Demonstrate proper cleaning of CNC machine

Competency: **Manufacture workpiece (e.g., rectangular, round, angular)**

Competency Builders:

Dry-run machine
Run part
Inspect part

Unit: Basic Materials Science

Competency: Demonstrate basic knowledge of metallurgy

Competency Builders:

Define metallurgy
Define metal forming (e.g., general process)
Identify forming industries (e.g., stamping, forging, fabricating)
Describe metal forming principles
Describe the metal forming process
Identify frequently used metals
Describe the crystalline structures of metals
Use periodic chart to evaluate metals
List chemical properties of common metals
List physical properties of common metals
Describe measures of metal strength
Identify examples of raw materials processed by hot rolling, cold rolling, forging, drawing, extrusion, spinning and powered metallurgy
Explain secondary finishing operations (e.g., paint, anodizing)

Competency: Demonstrate basic knowledge of heat treatment

Competency Builders:

Describe process of heat treating
Define types of heat treating (e.g., case hardening, annealing, drawing, stress relieving, tempering, quenching, critical temperature)

Competency: **Demonstrate basic knowledge of metal characteristics and formability**

Competency Builders:

Explain metal and formability basics
Explain metal grades and coatings
Explain part contour analysis
Explain tensile test
Explain LDH test
Explain bend test
Explain hold expansion test
Explain R-value test
Explain hardness test
Explain cup test
Explain friction test
Explain surface test
Explain interpretation of metal characteristics tests
Describe blank/die interactions (e.g., friction)
Describe friction and forming process
Describe circle grid basics
Describe circle grid applications
Describe formability diagnostics
Describe the documentation process

Competency: **Demonstrate basic knowledge of casting**

Competency Builders:

Identify frequently used metals
Describe crystalline structures of metals
Use periodic chart in evaluating metals
List chemical properties of common metals
List physical properties of common metals
Define permanent mold casting
Define shell mold casting
Define sand casting and pattern making
Define die casting
Identify basic casting terms
Identify advantages/disadvantages of casting processes

Competency: Demonstrate basic knowledge of iron and its alloys

Competency Builders:

Define iron and its alloys
Describe iron manufacturing process
Describe the structure of iron and its alloys
List chemical properties of iron and its alloys
List physical properties of iron and its alloys
Describe iron and alloys property variables
Describe measures of strength for iron and its alloys
Identify examples of iron and its alloys processed by hot rolling, stamping, cold rolling, drawing, extrusion, spinning, casting, forging and machining
Perform tensile test
Perform Brinell test
Perform chemical analysis

Competency: Demonstrate basic knowledge of aluminum and its alloys

Competency Builders:

Define aluminum and its alloys
Describe aluminum manufacturing process
Describe the structure of aluminum
List chemical properties of aluminum
List physical properties of aluminum
Describe aluminum property variables
Identify examples of aluminum processed by cold rolling, drawing, extrusion, stamping, spinning, casting, forging and machining
Perform tensile test
Perform Brinell test
Perform chemical analysis

Competency: **Demonstrate basic knowledge of copper and its alloys (e.g., brass, bronze)**

Competency Builders:

Define copper and its alloys
Describe copper manufacturing process
Describe the structure of copper
List chemical properties of copper
list physical properties of copper
Describe copper property variables
Describe measures of copper strength
Identify examples of copper processed by cold rolling, drawing, extrusion, stamping, spinning, casting, forging and machining
Perform tensile test
Perform Brinell test
Perform chemical analysis

Competency: **Demonstrate basic knowledge of plastics and polymers**

Competency Builders:

Define thermo-analysis testing (e.g., melt flow, moisture control)
Define plastics and polymers
Describe plastics and polymers manufacturing processes
Describe structure of plastics and polymers
List chemical properties of plastics and polymers
List physical properties of plastics and polymers
Differentiate thermoset and thermoplastic
Describe plastics and polymer property variables
Describe measure of plastic and polymer strength
Identify examples of raw materials processed by machining, extrusion, stamping, injection molding, compression molding and injection compression molding
Identify molding defect (e.g., flash, sink marks, warp, contamination, wet material, stuck parts, short shot, burn marks, surface blemishes)
Identify secondary operations performed on plastic parts (e.g., plating, milling, painted)
Perform tensile test
Perform R-value test

Competency: **Demonstrate basic knowledge of concrete and other ceramics**

Competency Builders:

Explain concrete tools and applications (e.g., float, chairs)
Describe the formation of concrete
List types of cements and their uses
Define qualities of concrete (i.e., strength, consistency, homogeneity, tensile force, abrasion, heat of hydration, and heat and sulfate resistance)
List tests used in concrete production (e.g., slump test, test of fineness modules)
List protective practices used after pouring

Competency: **Demonstrate knowledge of corrosion and protection**

Competency Builders:

Identify causes of corrosion
Identify types of corrosion
List solutions to minimize problems
Identify corrosion testing

Competency: **Demonstrate basic knowledge of rubber manufacturing**

Competency Builders:

Explain history of rubber industry
Compare properties of natural rubber with those of synthetic rubber
Explain how natural rubber is manufactured
Explain vulcanizaton, mastication, and cure systems
Explain use of compounding ingredients (e.g., carbon blacks, accelerators, fillers, antioxidants)
Explain press and autoclave curing
Explain how synthetic rubber is manufactured (e.g., neoprene, butyl, styrene-butadiene)
Explain rubber testing (e.g., tensile, durometer)

Unit: Welding Basics

Competency: Perform basic gas welding, brazing, and cutting

Competency Builders:

Follow safety guidelines
Differentiate welding and brazing
Identify gas welding and cutting equipment and accessories
Use personal protective equipment required for welding and cutting
Explain capillary attraction as it applies to metal
Demonstrate proper lighting, adjusting, and shutting down of gas torch
Layout mild steel
Cut mild steel
Braze mild steel
Solder non-ferrous metals
Apply basic metallurgy technology

Competency: Perform basic arc welding/cutting (i.e., stick)

Competency Builders:

Identify arc welding equipment and accessories
Explain process of resistance welding
Explain process of projection welding
Explain process of flash-butt welding
Explain process of laser welding
Explain process of friction welding
Explain process of spot welding
Explain process of shielded metal-arc welding (SMAW)
Explain process of gas metal-arc welding (GMAW)
Explain process of gas tungsten-arc welding (GTAW)
Explain process of plasma-arc cutting
Explain process of carbon arc gouging and cutting
Explain process of welding plastics
Explain welding rod alloys
Read welding rods
Explain mild steel welding rod
Explain low hydrogen welding electrode
Explain rationale for preheating and post-heating metal
Explain (GMAW) welding in flat, horizontal, vertical positions
Explain (GTAW) welding on mild steel, stainless steel, and aluminum
Explain process of build up and hard facing
Troubleshoot fusion of materials
Weld stainless steel using (SMAW) process
Weld steel requiring preheat
Weld cast iron
Weld aluminum
Apply basic metallurgy technology

Unit: Basic Diemaking

Competency: Explains the basics of diemaking

Competency Builders:

State purpose of die
List types of dies (e.g., pierce, form, flange, spank, CAM, progressive, draw)
Describe characteristics of pierce die (e.g., purpose, operating processes, dimensions, capabilities, limitations, manual/automatic aspects)
Describe characteristics of form die (e.g., purpose, operating processes, dimensions, capabilities, limitations, manual/automatic aspects)
Describe characteristics of spank die (e.g., purpose, operating processes, dimensions, capabilities, limitations, manual/automatic aspects)
Describe characteristics of progressive die (e.g., purpose, operating processes, dimensions, capabilities, limitations, manual/automatic aspects)
Describe characteristics of draw die (e.g., purpose, operating processes, dimensions, capabilities, limitations, manual/automatic aspects)

Competency: Produce small form die

Competency Builders:

Draw details of form die
Select proper materials
Fabricate details from prints
Mount details on shoe
Operate die
Check die performance

Competency: Produce small pierce or punch die

Competency Builders:

Draw details of pierce die
Select proper materials
Fabricate details from prints
Mount details on shoe
Operate die
Check die performance

Unit: Basic Moldmaking

Competency: Explain processes for building molds

Competency Builders:

Describe process of making a mold
Describe machinery used in moldmaking
Describe types of metal castings used for molds
Identify types of components used in the forming process (e.g., gibs, core, cavity, slides, heaters)
Identify surface finishes for molds
Identify types of molding materials (e.g., glass, plastic, rubber, die cast, pressware)
Describe the fitting and assembly process

Competency: Describe the process of extrusion

Competency Builders:

Explain extrusion method
Identify machines and dies used in extrusion
Identify applications for extrusion

Competency: Describe compression molding

Competency Builders:

Explain compression molding method
Identify machines and molds used in compression molding
Identify applications for compression

Competency: Describe injection molding

Competency Builders:

Explain injection molding method
Identify machines and molds used in injection molding
Identify applications for injection molding

Competency: Describe blow molding

Competency Builders:

Explain blow molding method
Identify machines and molds used in blow molding
Identify applications for blow molding

Competency: Describe thermoforming

Competency Builders:

Explain thermoforming method
Identify machines and molds used in thermoforming
Identify applications for thermoforming

Competency: Describe rotational molding

Competency Builders:

Explain rotational molding method
Identify machines and molds used in rotational molding
Identify applications for rotational molding

Competency: Describe calendering method

Competency Builders:

Explain calendering method
Identify machines and molds used in calendering
Identify applications for calendering

Competency: Describe foam processes

Competency Builders:

Explain foam processes method
Identify machines and materials used in foam processing
Identify applications for foam processes

Competency: **Describe powder coating**

Competency Builders:

Explain powder coating method
Identify machines and materials used in powder coating
Identify applications for powder coating

Unit: Metal Stamping Dies

Competency: Describe different types of dies

Competency Builders:

Describe crimping die
Describe parts assembly die
Describe CAM bending die
Describe blanking die
Describe pierce die
Describe forming die
Describe draw die
Describe progressive die

Competency: Describe fixtures

Competency Builders:

Describe crimping fixture
Describe locating fixture
Describe press fitting fixture
Describe riveting fixture
Describe welding fixture

Competency: Design product

Competency Builders:

Draw isometric view of product
Construct model (e.g., clay, form, wood, plastic)
Scan model
Wire frame data
Create computerized model
Interface model with CAD/CAM
Reproduce surface finish
Identify materials for product
Create prototype
Validate product
Standardize product

Competency: Troubleshoot design errors

Competency Builders:

Isolate cause of die component breakage
Isolate cause of failure of parts to be removed from die
Isolate cause of incorrect punch clearance
Isolate cause of incorrect die clearance
Isolate cause of misfitting die components

Competency: Correct design errors

Competency Builders:

Correct cause of die component breakage
Correct cause of failure of parts to be removed from die
Correct cause of improper punch clearance
Correct cause of improper die clearance
Correct cause of misfitting die components

Competency: Explain die processing

Competency Builders:

Describe preplanning activities
Describe die layout
Identify die operations (e.g., number, purpose and sequence of die operations)
Describe feasibility study development
Describe sequence of operations from die construction

Competency: Explain pattern shop applications

Competency Builders:

Describe pattern shop activities
Describe die pattern materials (e.g., wood, styrofoam, ceramic)
Describe die pattern construction
Describe casting of dies
Describe casting of components
Describe model process steps
Describe model use

Competency: Explain die construction (e.g., production and operation techniques)

Competency Builders:

Explain need for basic machining skills
Explain need for sculptured machining skills
Explain EDM functions
Explain die material standards
Describe tool and die welding
Describe punch finishing
Explain lifter/gauging systems
Explain pressure systems
Describe function of cams

Competency: Explain the die tryout process

Competency Builders:

Explain need to use analytical problem solving for die tryout
Describe process documentation
Describe die modification techniques
Describe blank modification techniques
Describe die buy-off
Describe die release
Describe part release
Describe die coatings
Describe die treatments

Competency: **Explain die maintenance**

Competency Builders:

Describe planned die maintenance
Describe predictive die maintenance
Describe preventive die maintenance
Describe die maintenance troubleshooting techniques
Describe die refurbishment techniques

Unit: Press Technology

Competency: Explain press operation

Competency Builders:

Identify types of presses
Describe functions of presses
Identify capacity of presses
Describe shuttheight
Identify operator safety devices

Competency: Demonstrate knowledge of press accessories

Competency Builders:

Describe function of monitors, proximity switches and die protection
Describe function of loaders
Describe function of roller levelers
Describe function of decoilers
Describe function of feeders
Describe function of transfer mechanisms
Describe function of lubricators and coolants
Describe processing of coil steel
Describe use of quick die change
Describe press set-up

Unit: Sheet Metal Fabrication

Competency: Demonstrate knowledge of sheet metal fabrication

Competency Builders:

Describe sheet metal fabricated products
Describe press working process
Describe process(es) of straightening metal
Describe metal finishing and coating
Explain bend allowances
Identify materials used for sheet metal fabricaton (e.g., hot roll, cold roll, aluminum, stainless)
Explain process of determining metal thicknesses
Explain process of layout
Explain process of fastening
Explain process of punch and die clearance and alignment
Demonstrate the capability to finish (cleaning, painting, plating)
Demonstrate CADD uses for layout

Competency: Describe types of metal fabrication manufacturing

Competency Builders:

Describe shear
Describe press brake
Describe cut-to-length lines
Describe roll forming
Describe CNC turret presses
Describe FMS cells

Competency: Layout sheet metal

Competency Builders:

Lay out 90° ells
Lay out 45° and 30° ells
Use radial line development to lay out
Use development by triangulation to lay out

Competency: Fabricate components

Competency Builders:

Layout design
Measure materials
Create pattern and/or prototype
Use hand tools
Cut materials
Form materials
Use fasteners
Spot weld

Competency: Perform sheet metal fabrication

Competency Builders:

Identify sheet metal fabrication jobs
Identify tools (e.g., manual and hand powered) needed
Fabricate round ells
Fabricate tees
Fabricate pyramids
Fabricate cones
Fabricate square to round transitions

TECH PREP

"GET SERIOUS . . . ABOUT SUCCESS"

Plastics Technician

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—NOTICE—

Each Tech-Prep Competency Profile developed should respond to the labor market demands of your Tech Prep Consortium. Therefore, the following pages should be examined carefully before being selected for use in TCP Part I. **[See "The TCP Process" for more information.]** For example, in some cases the number of units far exceeds the amount of content that can be covered within a 4 + 2 TPAD Program. All the units listed in this section will not necessarily apply to your situation, nor will all the competencies within each unit be appropriate. Note that several units appear within each specific occupation and would need to only appear once if you are compiling a cluster of occupations. **[See "TCP Matrix" and "How to Use the TCP Binder" for more information.]**

Unit: Communications Literacy

NOTE: This content was extracted from the 9-12 cluster of Ohio's Model Language Arts Program. Due to statewide initiatives other than Tech Prep, this literacy unit was not altered to meet competency-based criteria. Each literacy unit forms a critical link between academic teachers and members of business, industry, and labor. [See "The TCP Process" for more information.]

Subunit: Reading—Structure

Competencies:

RS1	Exhibit knowledge of language structure
RS2	Recognize that there may be more than one interpretation of reading selections
RS3	Recognize various literary devices
RS4	Recognize and discuss literary elements
RS5	Develop and use an increasingly sophisticated vocabulary gained through context
RS6	Apply knowledge of language structure to reading
RS7	Explain why there may be more than one interpretation of reading selections
RS8	Recognize effect of literacy devices on meaning
RS9	Analyze author's use of literary elements
RS10	Recognize relationship of structure to meaning
RS11	Describe various interpretations and meaning levels in reading selections
RS12	Characterize author's use of literary devices
RS13	Characterize use of literary techniques
RS14	Critique a variety of literature with regard to plot, dialogue, theme, setting, and characterization
RS15	Apply an expanding vocabulary gained through reading
RS16	Explain various interpretations and meaning levels in reading selections
RS17	Analyze use of literary techniques (e.g., extended metaphor, simile, personification, hyperbole, pun, alliteration)
RS18	Understand use of literary devices (e.g., irony, satire, allegory, onomatopoeia)
RS19	Analyze and synthesize pieces of literature with regard to plot, dialogue, theme, setting, and characterization

Subunit: Reading—Meaning Construction

Competencies:

RM1 Demonstrate ability to recognize appropriate pre-reading strategies
RM2 Describe effectiveness of a reading selection
RM3 Read to clarify personal thinking and knowledge
RM4 Support interpretation of text by locating and citing specific information
RM5 Develop personal response to a variety of literary works
RM6 Recognize diverse literary interpretations
RM7 Engage in self-selected reading activities
RM8 Confirm and extend meaning in reading by researching new concepts and facts
RM9 Self-monitor and apply corrective strategies when communication has been interrupted or lost
RM10 Use features of literary genres to extend meaning
RM11 Assess effectiveness of a selection read
RM12 Use reading as a possible problem-solving strategy to clarify personal thinking and knowledge
RM13 Use knowledge of semantic elements (e.g., figurative language, denotation, connotation, dialect) to clarify meaning when reading
RM14 Predict, recognize, interpret, and analyze themes based on familiarity with author's work
RM15 Compare and contrast literary genres
RM16 Assess validity and quality of selection read
RM17 Clarify meaning when reading
RM18 Compare personal reaction to critical assessment of a literary selection
RM19 Assess validity of diverse literary interpretations
RM20 Use reference books to find, evaluate, and synthesize information
RM21 Identify tone of a literary work
RM22 Critique validity of diverse literary interpretations
RM23 Integrate personal reaction to and critical assessment of a literary selection

Subunit: Reading—Application

Competencies:

RA1	Select and read material for personal enjoyment and information
RA2	Read a variety of complete, unabridged works
RA3	Employ various reading strategies according to purpose
RA4	Participate in selection of books, materials, and topics for literature study groups
RA5	Develop and apply knowledge of the interrelationship of concepts
RA6	Read selections from a variety of styles and formats, recognizing that style and format influence meaning
RA7	Extend value of reading, writing, speaking, viewing, and listening by pursuing, through reading, new concepts and interests developed as a result of these activities
RA8 of	Read extensively from a particular author's work and explain elements author's style

Subunit: Reading—Multidisciplinary

Competencies:

RM1	Connect themes and ideas across disciplines through literature
RM2	Read to facilitate learning across curriculum
RM3	Read to develop awareness of human rights and freedom
RM4	Participate actively in a community of learners
RM5	Recognize and explain interaction between literature and various cultural domains (e.g., social technological, political, economic)
RM6	Explore and analyze a variety of cultural elements, attitudes, beliefs, and value structures by men and women of many racial, ethnic, and cultural groups
RM7	Value thinking and language of others
RM8	Relate literature to historical period about which or in which it was written
RM9	Read to facilitate content learning

Subunit: Writing—Structure

Competencies:

WS1	Develop and expand a repertoire of organizational strategies (e.g., narration, comparison/contrast, and description) through a practice and discussion
WS2	Clarify word choice according to audience, topic, and purpose
WS3	Locate and correct errors in usage, spelling, and mechanics using a variety of resources
WS4	Recognize information gained from primary and secondary sources
WS5	Develop writing which contains ordered, related, well-developed paragraphs with sentences of varied lengths and patterns
WS6	Use information from a variety of sources to develop an integrated piece of writing
WS7	Evaluate and revise writing to focus on such things as audience, tone, and purpose
WS8	Recognize differences between documentation and reference list styles
WS9	Develop extended pieces of writing which contain ordered, related, well-developed paragraphs with sentences of varied lengths and patterns
WS10	Select from a repertoire of organization strategies a pattern appropriate to a topic
WS11	Synthesize information from a variety of sources
WS12	Refine word choice and tone according to audience, situation, and purpose
WS13	Appropriately cite information gained from primary and secondary sources
WS14	Use style manuals or software to prepare documentation and reference lists
WS15	Develop effectively organized pieces of expository writing containing strong voice, clear thesis, and well-developed ideas
WS16	Identify organization patterns appropriate to writing topic
WS17	Respond to others' suggested revisions to a writing piece

Subunit: Writing—Meaning Construction

Competencies:

WM1	Demonstrate knowledge of the recursive nature of the writing process by applying it appropriately to various topics, situations, and audiences
WM2	Develop criteria for writing evaluation using scoring guides and peer/teacher assistance to clarify meaning
WM3	Respond to others' suggested revisions to a piece of writing
WM4	Use word processing, graphics, and publishing aids to construct meaning in writing
WM5	Engage in self-initiated writing activities
WM6	Incorporate personal criteria with generally accepted standards for writing evaluation
WM7	Evaluate, analyze, and synthesize information for writing
WM8	Evaluate own writing using personal and established scoring criteria
WM9	Assess personal/peer revisions to a writing piece
WM10	Recognize and refine personal writing styles

Subunit: Writing—Application
Competencies:

WA1	Apply appropriate writing techniques suitable for varied writing tasks
WA2	Use sentence-combining techniques to improve syntactic fluency and maturity
WA3	Write in response to prompted and self-selected topics in practical, persuasive, descriptive, narrative, and expository domains
WA4	Develop personal voice in writing
WA5	Consider audience and purpose for writing
WA6	Develop criteria for selection and potential development of topic
WA7	Write in a journal or learning log to clarify personal thinking and knowledge
WA8	Apply an expanding vocabulary gained through writing
WA9	Make judicious use of reference sources (e.g., dictionary, thesaurus, on-lien data base, encyclopedia)
WA10	Demonstrate, an appreciation for aesthetically pleasing language through word choice and style
WA11	Apply revising and editing strategies needed for writing task
WA12	Vary sentence lengths and patterns
WA13	Refine personal voice in writing
WA14	Vary styles and formats for intended purpose and audience
WA15	Apply criteria for selection and development of topic
WA16	Participate in peer review of writing in progress
WA17	Use transitions between sentences, ideas, and paragraphs in writing
WA18	Revise and edit papers extensively in preparation for presentation/publication
WA19	Develop a variety of genres
WA20	Focus writing and tone on such elements as audience, situation, and purpose
WA21	Develop topic fully and appropriately
WA22	Use writing process to clarify personal thinking and knowledge
WA23	Apply appropriate recursive writing process as suggested by writing task and writer's process
WA24	Develop an extended piece of writing
WA25	Revise writing and tone to assure focus on such elements as audience, situation, and purpose
WA26	Use writing process to write reflectively

Subunit: Writing—Multidisciplinary

Competencies:

WM1	Use writing process for learning across curriculum
WM2	Use writing process to demonstrate knowledge of need for human rights and freedom
WM3	Value and apply collaborative skills in writing process
WM4	Write in response to reading, speaking, viewing, and listening
WM5	Use multidisciplinary resources in writing projects
WM6	Use writing process to facilitate learning across curriculum
WM7	Recognize value of and engage in collaboration in writing process
WM8	Use communication processes to develop a published writing piece in collaboration with others
WM9	Record experiences and observations related to content learning
WM10	Apply collaborative skills in writing process
WM11	Write collaboratively with peers
WM12	Use cross-disciplinary resources in writing projects

Subunit: Listening/Visual Literacy—Structure

Competencies:

LS1	Listen to and view a wide variety of genres
LS2	Become aware of an author's style through listening and viewing a variety of works
LS3	Recognize correct and appropriate grammar, diction, and syntax
LS4	Expand vocabulary through listening to and viewing varied media
LS5	Recognize beauty of language
LS6	Enhance recognition of an author's style through listening and viewing a variety of works
LS7	Recognize use and misuse of language in media
LS8	Refine knowledge of style through listening and viewing multiple works by the same author
LS9	Expand and refine grammar, diction, and syntax through listening
LS10	Compare authors' styles through viewing and listening to their works
LS11	Expand knowledge of complex grammar, diction, and syntax issues

Subunit: Listening/Visual Literacy—Meaning Construction

Competencies:

LM1	Develop critical thinking skills necessary to evaluate media and assess oral presentations
LM2	Compare new oral texts to past experiences and knowledge in order to enhance comprehension
LM3	Recognize how rhythmic patterns, silence, and cadences enhance quality of speech and literature
LM4	Focus listening and viewing on themes and/or plots
LM5	Gather information from listening and viewing experiences to enhance research
LM6	Use critical thinking skills to evaluate media and oral presentations
LM7	Use prior knowledge and experiences to facilitate comprehension of new oral texts
LM8	Identify rhythmic and time patterns in speech and literature
LM9	Identify and analyze themes and/or plots when listening and viewing
LM10	Use information gathered from listening and viewing experiences to expand research
LM11	Enhance use of critical thinking skills to evaluate media and oral presentations
LM12	Consider prior knowledge and experiences when attempting to understand the meaning of new texts
LM13	Appreciate rhythmic and time patterns of speech and literature
LM14	Select viewing and listening materials to support written text
LM15	Evaluate media and oral presentations analytically and critically
LM16	Organize prior knowledge and experiences to comprehend new texts
LM17	Organize and use viewing and listening materials to support written text

Subunit: Listening/Visual Literacy—Application

Competencies:

LA1	Listen attentively during oral reading
LA2	Use media as stimuli for learning and thinking
LA3	Develop knowledge of structure through art, music, and literature
LA4	Use electronic media to enhance and highlight language learning
LA5	Listen and view for entertainment and enjoyment
LA6	Use technology and other media as means of expressing ideas

Subunit: Listening/Visual Literacy—Multidisciplinary

Competencies:

LM1	Facilitate learning across curriculum through critical listening and viewing
LM2	Engage in individual, small-group, and whole-group listening and viewing activities
LM3	Develop language arts (e.g., viewing, listening) projects collaboratively
LM4	Investigate language and cultural differences through listening and viewing activities
LM5	Participate in a community of learners through productive listening

Subunit: Oral Communication—Structure

Competencies:

OS1	Refine oral communication skills
OS2	Demonstrate knowledge of grammar, usage, and syntax when presenting
OS3	Select topics and vocabulary suitable to audience
OS4	Organize notes and ideas for speaking
OS5	Use language imaginatively
OS6	Modulate voice to meaning when interpreting literature orally
OS7	Organize notes and ideas for formal, semiformal and informal presentations of information
OS8	Refine speaking techniques for formal, semiformal, and informal settings
OS9	Develop repertoire of organizational strategies for presenting information orally
OS10	Expand vocabulary to fit topic
OS11	Select topics suitable to audience, situation, and purpose
OS12	Select appropriate strategies when organizing notes and ideas for speaking

Subunit: Oral Communications—Meaning Construction
Competencies:

OM1	Make connections between prior knowledge and new information for oral presentations
OM2	Participate in informal speaking activities
OM3	Use interviewing techniques to gather information
OM4	Communicate orally to entertain and to inform
OM5	Participate in group communication activities
OM6	Take and organize notes when preparing speech/presentation
OM7	Interpret texts orally to illustrate meaning
OM8	Respond to needs of various audiences
OM9	Gather and assess information for speaking
OM10	Communicate orally to inform and persuade
OM11	Prepare and deliver formal speech/presentation
OM12	Participate in a variety of oral interpretations
OM13	Assess needs of audience and adjust language and presentation according to their knowledge
OM14	Analyze and synthesize information for speaking
OM15	Describe effectiveness of literary selection
OM16	Describe topic or idea in order to clarify personal/audience thinking
OM17	Analyze and synthesize information gathered from a variety of sources for speaking
OM18	Describe validity and/or quality of a literary selection and justify selection
OM19	Interpret orally a variety of literature
OM20	Describe topic or idea to clarify meaning for others

Subunit: Oral Communication—Application
Competencies:

OA1	Become proficient at using interviewing techniques
OA2	Give an oral interpretation for a specific audience
OA3	Develop and apply oral communication skills for cooperative/collaborative learning
OA4	Use oral communication for a variety of purposes and audiences (e.g., negotiations, book reviews, rationales)
OA5	Develop and apply decision-making strategies
OA6	Practice interviewing techniques
OA7	Apply interviewing techniques to purposeful interviews
OA8	Focus oral interpretation on a specific audience

Subunit: Oral Communications—Multidisciplinary

Competencies:

OM1	Value thinking and language of others
OM2	Develop oral projects collaboratively
OM3	Be involved in individual, small-group, and whole-group language activities
OM4	Participate actively in a community of learners
OM5	Investigate language and cultural differences through oral language activities

Unit: Mathematics Literacy

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Subunit: Numbers and Number Relations

Competencies:

NR1	Compare, order, and determine equivalence of real numbers
NR2	Estimate answers, compute, and solve problems involving real numbers
NR3	Compare and contrast real number system, rational number system, and whole number system
NR4	Extend knowledge to complex number system and develop facility with its operation

Subunit: Measurement

Competencies:

M1	Estimate and use measurements
M2	Understand need for measurement and probability that any measurement is accurate to some designated specification
M3	Understand and apply measurements related to power and work
M4	Understand and apply measurement concepts of distance-rate-time problems and acceleration problems
M5	Use real experiments to investigate elasticity, heat, sound, electricity, magnetism, light, acceleration, velocity, energy, and gravity
M6	Use real-world problem situations involving mass and weight
M7	Use real-world problem situations involving simple harmonic motion
M8	Establish ratios with and without common units
M9	Construct and interpret maps, tables, charts, and graphs as they relate to real-world mathematics
M10	Understand and solve rate-change problems
M11	Understand and solve right triangle relationships as they relate to measurement, specifically to Pythagorean theorem
M12	Graph and interpret ordered pairs
M13	Compute total sales from a variety of items
M14	Comprehend and compute rates of growth or decay
M15	Comprehend, compute, and interpret real problems involving annuities

Subunit: Measurement (continued)
Competencies:

M16 Develop an ability to identify real problems and provide possible solutions
M17 Express and apply different types of measurement scales
M18 Identify area and volume

Subunit: Estimation and Mental Computation
Competencies:

E1 Use estimation to eliminate choices in multiple-choice tests
E2 Use estimation to determine reasonableness of problem situations in a wide variety of applications
E3 Estimate shape of graphs of various functions and algebraic expressions
E4 Use mental computation when computer and calculator are inappropriate

Subunit: Data Analysis and Probability
Competencies:

D1 Organize data into tables, charts, and graphs
D2 Understand and apply measures of central tendency, variability, and correlation
D3 Use curve fitting to predict from data
D4 Use experimental or theoretical probability, as appropriate, to represent and solve problems involving uncertainty
D5 Use computer simulations and random number generators to estimate probabilities
D6 Test hypotheses using appropriate statistics
D7 Read, interpret, and use tables, charts, and graphs to identify patterns, note trends, draw conclusions, and make predictions
D8 Identify probabilities of events involving unbiased objects
D9 Use sampling and recognize its role in statistical claims
D10 Design a statistical experiment to study problem, conduct experiment, and interpret and communicate outcomes
D11 Describe normal curve in general terms and use its properties
D12 Create and interpret discrete probability distributions
D13 Understand concept of random variable
D14 Apply concept of random variable to generate and interpret probability distributions, including binomial, uniform, and chi square

Subunit: Algebra
Competencies:

A1	Describe problem situations by using and relating numerical, symbolic, and graphical representations
A2	Use language and notation of functions in symbolic and graphing settings
A3	Recognize and use equivalent zeros of a function, roots and the solution of an equation in terms of graphical and symbolic representations
A4	Describe and use logic of equivalence in working with equations, inequalities, and functions
A5	Develop graphical techniques of solution for problem situations involving functions
A6	Explore and describe characterizing features of functions
A7	Make arguments and proofs in algebraic settings
A8	Factor difference of two squares
A9	Identify slope, midpoint, and distance
A10	Explore and combine rational functions
A11	Explore factoring techniques
A12	Solve quadratic equations by factoring and formula
A13	Set up and solve linear equations
A14	Solve systems of linear equations with two variables
A15	Describe geometric situations and phenomena using variables, equations, and functions
A16	Describe measures of central tendency, mean, median, mode, and variance algebraically and graphically
A17	Represent inequalities on number line and in coordinate plane
A18	Use coordinate arguments in making geometric proofs
A19	Symbolize transformations of figures and graphs
A20	Explore geometric basis for functions of trigonometry
A21	Graph linear functions
A22	Develop and use vectors to represent direction and magnitude including operations
A23	Use polar and parametric equations to describe, graph, and solve problem situations
A24	Represent sequences and series as functions both algebraically and graphically
A25	Explore recursive functions and procedures using spreadsheets, other computer utilities, and appropriate notions
A26	Describe and solve algebraic situations with matrices
A27	Describe and use inverse relationship between functions including exponential and logarithmic

Subunit: Algebra (continued)
Competencies:

A28 Analyze and describe errors and error sources that can be made when using computers and calculators to solve problems
A29 Decide whether problem situation is best solved using computer, calculator, paper and pencil, or mental arithmetic/estimation techniques
A30 Explore relationships between complex numbers and vectors
A31 Make arguments concerning limits, convergence and divergence in context involving sequences, series, and other types of functions
A32 Represent transformations in plane with matrices
A33 Contrast and compare algebra's of rational, real, and complex numbers with characteristics of a matrix algebra system
A34 Construct polynomial approximations of a function over specified intervals of convergence
A35 Examine complex numbers as zeros of functions
A36 Translate verbal statements into symbolic language
A37 Simplify algebraic expressions
A38 Use laws and exponents (including scientific notation)
A39 Expand and extend idea of vectors and linear algebra to higher dimensional situations
A40 Use the idea of independent basis elements for a vector space and associated fundamental concepts of finite dimensional linear algebra
A41 Develop and communicate arguments about limit situations
A42 Use matrices to describe and apply transformations
A43 Develop and use polar and parametric equations to represent problem situations
A44 Explore proofs by mathematical induction

Subunit: Geometry

Competencies:

G1	Create and interpret drawings of three-dimensional objects
G2	Represent problem situations with geometric models and apply properties of figures
G3	Apply Pythagorean theorem
G4	Demonstrate knowledge of angles and parallel and perpendicular lines
G5	Explore inductive and deductive reasoning through applications to various subject areas
G6	Translate between synthetic and coordinate representations
G7	Identify congruent and similar figures using transformation with computer programs
G8	Deduce properties of figures using transformations and coordinates
G9	Use deductive reasoning
G10	Explore compass and straightedge constructions in context of geometric theorems
G11	Demonstrate knowledge of and ability to use proof
G12	Use variety of proof techniques (e.g., synthetic, transformational, and coordinate)
G13	Use variety of proof formats, including T-proof (i.e., two-column) and paragraph proof
G14	Explore different proof strategies
G15	Investigate different proofs of theorems
G16	Develop knowledge of an axiomatic system
G17	Apply transformations and coordinates in problem solving
G18	Represent problem situations with geometric models and apply properties of figures
G19	Deduce properties of figures using vectors
G20	Analyze properties of Euclidean transformations and relate translations to vectors
G21	Apply vectors in problem solving
G22	Develop further knowledge of axiomatic systems by investigating and comparing various geometry's

Subunit: Patterns, Relations, and Functions

Competencies:

P1 Model real-world phenomena with polynomial and exponential functions

P2 Explore relationship between zeros and intercepts of functions

P3 Translate among tables, algebraic expressions, and graphs of functions

P4 Use graphing calculator or computer to generate graph of a function

P5 Explore relationship between a linear function and its inverse

P6 Describe and use characteristics of polynomial functions in problem-solving situations

P7 Explore conic sections and graph using graphing calculator or computer

P8 Apply trigonometric functions to problem situations involving triangles

P9 Discover relationships between algebraic description, kind, and properties of conic

P10 Explore periodic real-world phenomena using sine and cosine functions

P11 Analyze effects of parameter changes on graphs

P12 Use graphing calculator or computer to graph functions

P13 Develop an knowledge of rational and transcendental functions

P14 Understand connections between trigonometric and circular functions

P15 Use circular functions to model periodic real-world functions

P16 Solve trigonometric equations and verify trigonometric identities

P17 Understand connections between trigonometric, exponential, and logarithmic functions and polar coordinates, complex numbers, and series

P18 Model real-world phenomena with a variety of functions

P19 Graph using polar coordinates

P20 Explore graphs in three dimensions

P21 Explore functions of several variables

P22 Explore recursive functions using spreadsheets and/or programming languages

Unit: Science Literacy

NOTE: This content was extracted from the 9-12 cluster of Ohio's Draft Model Science Program. Due to statewide initiatives other than Tech Prep, this literacy unit was not altered to meet competency-based criteria. Each literacy unit forms a critical link between academic teachers and members of business, industry, and labor. [See "The TCP Process" for more information.]

Subunit: Scientific Inquiry

Competencies:

Q1	Check the appropriateness and accuracy of measures and computations using various strategies (e.g., estimations, unit analysis, determination of significant figures)
Q2	Use ratios, proportions, and probabilities in appropriate problem situations
Q3	Translate information from and represent information in various forms with equal ease (e.g., tables, charts, graphs, diagrams, geometric figures)
Q4	Use existing algebraic formulas and create new ones in appropriate problem-solving situations
Q5	Estimate and justify probabilities of outcomes of familiar situations based on experimentation and other strategies
Q6	Invent apparatus and mechanical tools needed to perform unique tasks in various situations
Q7	Identify, compare, and contrast different modes of inquiry, habits of mind, and attitudes and dispositions
Q8	Design investigations that are safe and ethical (i.e., obtain consent and inform others of potential outcomes, risks and benefits, and show evidence of concern for human health and safety, concern for non-human species)
Q9	Make and read scale drawings, maps, models, and other representations to aid planning and understanding
Q10	Seek elaboration and justification of data and ideas, and reflect on alternative interpretations of the information
Q11	Use appropriate units for counts and measures
Q12	Create and use databases (electronic and other) to collect, organize, and verify data and observations
Q13	Design and conduct investigations with multiple variables
Q14	Communicate the results of investigations clearly in a variety of situations

Subunit: Scientific Inquiry (continued)
Competencies:

Q15	Examine relationships in nature, offer alternative explanations for the observations, and collect evidence that can be used to help judge among explanations
Q16	Trace the development (e.g., history, controversy, and ramifications) of various theories, focusing on supporting evidence and modification with new evidence
Q17	Select, invent, and use tools, including analog and digital instruments, to make and record direct measurements
Q18	Observe and document events and characteristics of complex systems
Q19	Explain the influence of perspective (e.g., spatial, temporal, and social) on observation and subsequent interpretations
Q20	Create multiple representations of the same data using a variety of symbols, descriptive languages, mathematical concepts, and graphic techniques
Q21	Generate testable hypotheses for observations of complex systems and interactions
Q22	Document potentially hazardous conditions and associated risks in selected homes and public areas
Q23	Participate in public debates, relying on documented and verified data to construct and represent a position on scientific issues
Q24	Construct and test models of physical, biological, social, and geological systems
Q25	Read, verify, debate, and, where necessary, refute research published in popular or technical journals of science (e.g., *Discover*, *Omni*, *Popular Mechanics*)
Q26	Explore discrepant events and develop and test explanations of what was observed
Q27	Conduct theory-based research using surveys, observational instruments, and other methods
Q28	Modify personal opinions, interpretations, explanations, and conclusions based on new information
Q29	Analyze error and develop explanations in various domains
Q30	Formulate taxonomic schemes based upon multivariate models that help to explain similarities and differences in form, distribution, behavior, survival, and origin of objects and organisms
Q31	Demonstrate various logical connections between related concepts (e.g., entropy, conservation of energy)
Q32	Account for discrepancies between theories and observations
Q33	Analyze the changes within a system when inputs, outputs, and interactions are altered

Subunit: Scientific Inquiry (continued)
Competencies:

Q34 Create, standardize, and document procedures

Q35 Determine the sources of significant disparities between the predicted and recorded results and change research procedures to minimize disparities

Q36 Research, locate, and propose applications for abstract patterns (e.g., fractals, Fibonacci sequences, string theory, orbitals)

Q37 Recognize and utilize classification systems for particles, elements, compounds, phenomena, organisms, and others for exploring and predicting properties and behaviors

Q38 Suggest and defend alternative experimental designs and data explanations (e.g., sampling, controls, safeguards)

Q39 Recognize and communicate differences between questions that can be investigated in a scientific way and those that rely on other ways of knowing

Q40 Draw conclusions based on the relationships among data analysis, experimental design, and possible models and theories

Q41 Suggest new questions as a result of reflection on and discussions about their own scientific investigations

Q42 Investigate, assess, and comment on strengths and weakness of the descriptive and predictive powers of science

Q43 Create new information from representations of data in a variety of forms (e.g., symbols, descriptive languages, graphic formats) utilizing a variety of techniques (e.g., interpolations, extrapolations, linear regressions, central tendencies, correlation's)

Subunit: Scientific Knowledge
Competencies:

K1 Investigate various types of dynamic equilibrium (e.g., biological, geological, mechanical, chemical)

K2 Investigate the relationship between the rates of energy exchange and the relative energy level of components with systems (e.g., tropic levels of ecosystems, osmosis, rate of heating and cooling, storms)

K3 Investigate patterns in the natural world (e.g., heredity, crystalline structures, population and resource distributions, diffraction, dispersion, polarization)

K4 Investigate models and theories that help to explain the interactions of components in systems (e.g., conservation of mass, energy, and momentum; food webs; natural selection; entropy; plate tectonics; chaos; relativity; social-psychology)

K5 Investigate degrees of kinship among organisms and groups of organisms

K6 Investigate the limits of the definition of life, and investigate organisms and physical systems that exist at or near these limits (e.g. viruses, quarks, black holes)

K7 Investigate estimates and measurements of a wide range of distances and rates of change

K8 Investigate the historical development of theories of change over time (e.g., natural selection, continental drift, the big bang, geologic change)

K9 Investigate physical and chemical changes in living and non-living systems (e.g., photosynthesis, weathering processes, glaciation, thermal effects of materials, energy cells)

K10 Investigate simulations of nuclear change (e.g., radioactivity, half life, carbon dating)

K11 Investigate conservation principles associated with physical, chemical, and nuclear changes

K12 Formulate descriptions of the impacts of various forms of mechanical and electromagnetic waves on various organisms on each other over time

K13 Formulate models and hypotheses for patterns in the natural world (e.g., earth structures, transportation systems, migrations, communications, constellations)

K14 Formulate explanations for the influences of objects and organisms on each other over time

K15 Formulate and interpret explanations for change phenomena (e.g., mass extinction's, stellar evolution, punctuated equilibrium, molecular synthesis)

Subunit: Scientific Knowledge (continued)
Competencies:

K16	Formulate and interpret explanations for the magnitudes of diversity at different periods of geologic time (e.g., mutation, global cataclysms, continental drift, competition, mass extinction's)
K17	Formulate interpretations of the structure, function, and diversity in a variety of organisms and physical systems (e.g., DNA and RNA variants, nucleons, interaction particles)
K18	Formulate understandings of geologic time (e.g., millennia, periods, epochs)
K19	Formulate an understanding of the historical development of the model of the universe
K20	Formulate explanations and representations of the production, transmission, and conservation of energy in biological and physical systems (e.g., weather, volcanism, earthquakes, electricity, magnetism, cellular respiration)
K21	Formulate models and hypotheses about patterns in the natural world (e.g., social behavior, molecular structure, energy transformation, entropy, randomness, aging, chaos, hormonal cycles)
K22	Formulate interpretations of the relationship between energy exchange and the interfaces between components within systems
K23a	Formulate estimations for the range of energies within and between various phenomena (e.g., thermal, electromagnetic, thermonuclear, chemical, electrical)
K23b	Formulate explanations for the historical development of descriptions of motions interactions and transformations of matter and energy (e.g., classical Newtonian mechanics, special and general relativity, chaos)
K24	Formulate models that can be used to describe fundamental molecular interactions in living and non-living systems (e.g., cell membranes, semiconductors).
K25	Formulate an understanding of the degree of relationship among organisms and objects based on molecular structure (e.g., proteins, nucleic acids)
K26	Formulate hypotheses and models that may account for observable events (e.g., electricity and magnetism, gravitation, atoms, bonding, chemical reactions, quantum effects, energy flow on biological systems, predator-prey relationships)
K27	Formulate models and hypotheses about change over time (e.g., natural selection, speciation, punctuated equilibrium, phyleytic gradualism, stellar evolution, plate tectonics, radioactive decay, quantum mechanical theory)

Subunit: Scientific Knowledge (continued)
Competencies:

K28 Formulate lists of limitations and propose refinements of standard classification systems (e.g., periodic table, IUPAC, Linnean, standard model)

K29 Formulate specific cases of limitations and possible exceptions of theories and principles regarding the interactions of moving objects and organisms (e.g., fluid flow in vessels, motion near the speed of light, Heisenberg uncertainty principle, meteorological prediction, local variation and diversity, predicting earthquakes, energy transport in cellular respiration)

K30 Formulate plans and contingencies that can be used to accommodate for changes to and stresses on systems (e.g., wildlife and habitat management, corrosion prevention, noise abatement, structure design)

K31 Formulate models of molecular, atomic, ionic, and subatomic structures and the physical and biological implications of these structures (e.g., genes, nucleons, quarks)

K32 Formulate estimates for a wide range of measurements and scales (e.g., angstroms to light years)

K33 Formulate and interpret representations of time from origin to present accounting for phenomena of scale (e.g., smoothness, punctuation's, chaos)

K34 Formulate interpretations of the historical development of various theories of possible causes of diversity among physical and biological phenomena (e.g., the works of Aristotle, Mendel, Darwin, McClintock)

K35 Formulate models and hypotheses that can be used to explain the interactions of components within technological and ecological systems

Subunit: Conditions for Learning Science
Competencies:

C1 Participate actively in dialogue about and resolution of community issues
C2 Assess information from various countries in the original language or translated form to ascertain the perspectives of many cultures
C3 Analyze the scientific ideas presented in science fiction stories and films
C4 Perform and repeat investigations to verify data, determine regularity, and reduce the impact of experimental error
C5 Present the results of investigations in a variety of forums
C6 Contribute to the decisions regarding topics for investigation
C7 Use various creative means to communicate interpretations of scientific ideas, concepts, phenomena, and events
C8 Consider the scientific thinking and language of others
C9 Individually and collaboratively produce clearly written representations of investigative results
C10 Fulfill responsibilities as part of a research group
C11 Select and utilize resources by various criteria (e.g., efficiency, effectiveness, health, safety) that are appropriate to the investigations being conducted by groups
C12 Present persuasive argument based on the scientific aspects of controversial issues
C13 Collect, store, retrieve, and manipulate information with available t technologies alleges that may range from hand processes up through computer applications
C14 Investigate social issues with a scientific perspective (e.g., human rights, wellness, economics, futurism, environmental ethics)
C15 Keep journals of observations and inferences made over an extended period of time and reflecting upon the impact of these recorded ideas on their thinking and actions
C16 Examine the intellect, perspectives, and ethics of notable scientists
C17 Collect and analyze observations made over extended periods of time and compare these to scientific theories
C18 Create presentations of scientific understandings using diverse modes of expressions
C19 Conduct formal scientific debates in the classroom
C20 Wonder about the likelihood of events that may occur by chance or coincidence
C21 Plan and conduct field trips and experiences for small and large groups
C22 Analyze the historical context which leads to and has lead to scientific t theories

Subunit: Conditions for Learning Science (continued)
Competencies:

C23 Seek information on topics of personal scientific interest from a variety of sources
C24 Conduct learner-developed investigations independently and collaboratively over periods of week and months
C25 Listen attentively and critically to presentations of scientific information made by others
C26 Conduct analyses of propaganda related to scientific issues
C27 Perform investigations that require observations over varying periods of time
C28 Experience scientific concepts as interpreted by other cultures through multimedia and local and global specialists
C29 Access appropriate technology to perform complicated, time-consuming tasks
C30 Relate historical accounts of science to the cultural context in which they were written
C31 Work as a contributing member of a collaborative research group
C32 Examine the influences of social and political structures and realities that contribute to inquiry about scientific issues
C33 Use technology (e.g., desktop publishing, teleconferencing, networking) to communicate scientific ideas
C34 Explore and analyze a variety of perspectives on science (e.g., works by men and women of many racial, ethnic, and cultural groups)
C35 Lead groups of learners of various ages in designing, planning, and conducting science activities
C36 Respect the scientific thinking of others and self
C37 Recognize and contrast different epistemologies
C38 Develop possible courses of action in response to scientific issues of local and global concern
C39 Determine the validity of research conclusions in relation to the design, performance, and results
C40 Develop multimedia presentations of group and individual research projects and investigations appropriate for a variety of audiences and forums
C41 Produce interesting and scientifically correct stories and present them using various modes of expression
C42 Reflect on the ideas and content found in their own journal records
C43 Examine ambiguous results and formulate explanations
C44 Recognize and synthesize the contributions to scientific thought of individuals from many cultures

Subunit: Conditions for Learning Science (continued)
Competencies:

C45 Construct models and simulations of the component structures and functions of living and non-living entities
C46 Lead multi-age groups in the examination of and planned resolution for scientific issues
C47 Recognize and choose members of research teams based upon the merit of their ideas and skills
C48 Construct a portfolio of products, documentation, and self-evaluations of his/her own abilities, skills, and experiences
C49 Synthesize scientific information from a variety of sources
C50 Evaluate and prioritize scientific issues based upon risk-benefit analyses
C51 Refining scientific skills from a variety of experiences

Subunit: Applications for Science Learning

Competencies:

A1 Answer student-determined questions by designing databases and drawing inferences from the analyses of the information in these data bases

A2 Make personal behavior decisions by interpreting information that has a scientific basis

A3 Propose courses of action that will validate and demonstrate personal understandings of scientific principles

A4 Guide other learners in their understanding of the interactions of technologies and society at various periods in time

A5 Promote and carry out practices that contribute to a sustainable environment

A6 Study and propose improvements in public services and systems in their community

A7 Choose consumer materials utilizing personal and environmental risk and benefit information

A8 Make inferences and draw conclusions using databases, spreadsheets, and other technologies

A9 Do simple trouble-shooting on common electrical and mechanical s ystems, identifying and eliminating possible causes of malfunctions

A10 Construct devices that perform simple, repetitive actions

A11 Investigate the functionality of various geometric shapes in the natural world and the designed world (e.g., translations from spherical to plane representations cause distortions, triangular shapes contribute to rigidity and stability in structures, round shapes minimize boundary for a given capacity)

A12 Make decisions regarding personal and public health

A13 Evaluate the social and ecological risks and benefits resulting from the use of various consumer products

A14 Analyze the contributions of advances in technology through history to his/her everyday life

A15 Identify and reduce risks and threats to a sustainable environment

A16 Extend the limits of human capabilities using technological enhancements

A17 Use and recognize various propaganda techniques

A18 Solve unique problems using the results of systematic analyses

A19 Choose everyday consumer products that utilize recent innovation and pass appropriate performance criteria

A20 Refine personal career interests through investigations of the diversity of manufacturing, research, service, and invention processes

Subunit: Applications for Science Learning (continued)
Competencies:

A21	Predict and investigate the working of toys and tools while controlling and manipulating variables (e.g., friction, gravity, forces)
A22	Write, follow, modify, and extend instructions (e.g., equations, algorithms, formulas, flow diagrams, illustrations)
A23	Create products, make inferences, and draw conclusions using databases, spreadsheets, and other technologies
A24	Predict various scenarios and propose solutions to community issues using scientific information (e.g., actuarial tables, census data, topographic maps, incidence data, climatic data)
A25	Use scientific evidence to consider options and formulate positions about the health and safety of others and him/herself
A26	Search for, use, create, and store objects and information using various strategies and methods of organization and access
A27	Research and write environmental impact statements of his/her own design
A28	Compare school-based science perspectives with those gained through cutting-edge technological applications
A29	Design management plans for natural and human-altered environments (e.g., woodlots, patios, lots, lawns, farmlands, forests)
A30	Refine personal career interests
A31	Promote public awareness of the interaction of technology with social i issues
A32	Advocate and propose courses of action for local and global scientific issues using global networks
A33	Use appropriate technologies to prepare and present the findings of investigations incorporating tables, graphs, diagrams, and text
A34	Make informed consumer choices by evaluating and prioritizing information, evidence, and strategies
A35	Develop an informed point-of-view that allows for validation or refutation of the scientific statements and claims of advocated before pursuing courses of action (e.g., contributing support, signing petitions, casting votes)
A36	Differentiate between observations and inferences in the exploration of evidence related to personal, scientific, and community issues
A37	Develop and write environmental impact and safety and hygiene management plans
A38	Use technology to collect, analyze, and communicate information (e.g., electronic networks, desktop publishing, remote sensing, graphing calculators, satellite telemetry, and others)
A39	Design, construct, and market inventions

Unit: Technology Literacy

NOTE: Over 500 Ohio business, industry, and labor representatives examined, altered, and then verified the content for this unit during the TCP Process. The original content was extracted from the Report of the Task Force on Technology Competence—Learner Goals for All Minnesotans, published by the Minnesota State Council on Vocational Technical Education. The Technology Literacy unit forms a critical link between all teachers and stresses the importance of technological impact on teaching and learning. [See "The TCP Process" for more information.]

Competencies:

T1 Demonstrate a systems view of technology based on the interdependence of social, political, economic, and ecological systems

T2 Assess the career, family, and personal development implications of technological change

T3 Demonstrate continuous learning via technology

T4 Demonstrate global appreciation for technology's potential effects on cultures, geographic areas, and the environment

T5 Apply historical perspective on technology to the development and use of new technologies

T6 Apply diverse technologies to store, access, process, create, and communicate information needed to solve problems

T7 Apply legal principles and ethical conduct to the use of technology

T8 Demonstrate competency in mathematics, science, social sciences, communication, and computer skills through the analysis, design, and evaluation of technological systems

T9 Analyze the potential of alternative technological systems to solve problems and/or to extend human capabilities

T10 Use a variety of tools, materials, and equipment in solving problems and extending human capabilities

T11 Assess risks and benefits of technological developments from an ecological, economic, social, and political perspective

T12 Value human diversity as part of a team in suggesting, designing, and testing solutions to technological problems

Unit: Employability Skills

Competency: Develop a career plan

Competency Builders:

Identify current interests and aptitudes
Identify common barriers to employment
Describe strategies to overcome employment barriers
Locate resources for finding employment
Research job trends
Identify career options
Identify advantages and disadvantages of career options (in addition to other than monetary)
Identify job requirements
Investigate education/training opportunities
Evaluate personal strengths and weaknesses

Competency: Prepare for employment

Competency Builders:

Identify traditional and non-traditional employment sources
Identify present and future employment opportunities (by geographic location)
Research job opportunities, including non-traditional careers
Compare salary ranges and benefit packages
Compile occupational profile
Identify rights and responsibilities of equal employment opportunity laws
Design resume and cover letter
Target resume
Secure references
Investigate generic and specific employment tests (e.g., civil service exam; drug screening)
Use follow-up techniques to enhance employment potential
Demonstrate legible written communication skills using correct grammar, spelling, punctuation, and concise wording
Describe methods for handling illegal questions on job application forms and during interviews
Write letter of application
Research prospective employer and services performed
Explain critical importance of personal appearance, hygiene, and demeanor
Interpret job description
Demonstrate appropriate interview question and answer techniques
Demonstrate methods for handling difficult interview questions
Evaluate job offers
Write letter of acceptance
Write letter of declination
Demonstrate good listening skills
Ask for the job tactfully
Participate in extracurricular activities (e.g., student government, community projects,)

Competency: Evaluate the importance of self-esteem as an employability skill

Competency Builders:

Identify factors that affect self-esteem
Compare effects of low self-esteem and high self-esteem
Identify strategies to promote positive self-esteem

Competency: Demonstrate job retention skills

Competency Builders:

Identify employer expectations regarding job performance, work habits, attitudes, personal appearance, and hygiene
Exhibit appropriate work habits and attitude
Demonstrate ability to set priorities
Identify behaviors to establish successful working relationships
Identify alternatives for dealing with harassment, bias, and discrimination based on race, color, national origin, sex, religion, handicap, or age
Identify opportunities for advancement
List reasons for termination
List consequences of being absent frequently from job
List consequences of frequently arriving late for work
Demonstrate interpersonal relations skills (i.e., verbal and written)
Demonstrate negotiation skills
Demonstrate teamwork
Follow chain-of-command
Exhibit appropriate job dedication

Competency: Demonstrate knowledge of work ethic

Competency Builders:

Define work ethic
Identify factors that influence work ethic
Differentiate law and ethics
Describe how personal values are reflected in work ethic
Describe how interactions in the workplace affect personal work ethic
Describe how life changes affect personal work ethic

Competency: Exhibit appropriate work ethic

Competency Builders:

Use time-management techniques
Avoid personal activity during work hours
Attend work as scheduled
Adhere to company and/or governmental policies, procedures, rules, and regulations
Exercise confidentiality
Demonstrate appropriate human relations skills
Adhere to rules of conduct
Accept constructive criticism
Offer constructive criticism
Take pride in work
Resolve conflict
Manage stress
Avoid sexual connotations and harassment
Adjust to changes in the workplace
Demonstrate punctuality
Assume responsibility for personal decisions and actions
Take responsibility for assignments
Follow chain-of-command

Competency: Apply decision-making techniques

Competency Builders:

Identify decision to be made
Identify ownership of decision to be made
Identify possible alternatives and their consequences
Make decisions based on facts, legality, ethics, goals, and/or culture
Apply time factor(s)
Present decision to be implemented
Evaluate decision made
Take responsibility for decision

Competency: Apply problem-solving techniques

Competency Builders:

Identify problem
Select appropriate problem solving tools/techniques
Identify root problem cause(s)
Track root problem cause(s)
Identify possible solutions and their consequences (e.g., long term, short term, crisis)
Use resources to explore possible solutions to problem
Contrast advantages and disadvantages of each solution
Identify appropriate action
Evaluate results
Identify post-preventive action

Competency: Exhibit characteristics for job advancement

Competency Builders:

Display positive attitude
Demonstrate knowledge of position
Perform quality work
Adapt to changing situations and technology
Demonstrate capability/responsibility for different positions
Identify characteristics of effective leaders
Identify opportunities for leadership in work place/community
Demonstrate initiative to affect change in workplace
Participate in continuing education/training program
Responds appropriately to criticism from employer, supervisor, or other employees
Exhibit awareness of corporate culture
Prepare for job setbacks
Exhibit continual growth based on performance evaluation
Set realistic goals

Unit: Professionalism

Competency: Project professional image

Competency Builders:

Define professionalism
Exhibit professional appearance
Exhibit professional manners
Project professional attitude
Identify individuals' vital role in organization
Exhibit proper etiquette in professionally-related situations

Competency: Achieve individual and professional goals

Competency Builders:

Set flexible, realistic, and measurable goals
Identify potential barriers to achieving goals
Identify strategies for addressing barriers to goal achievement
Breakdown long-term goals into short-term goals
Prioritize goals
Commit to goals
Adjust goals
Obtain support for goals
Reward goal achievement

Competency: Manage personal finances

Competency Builders:

Explain need for personal management records
Balance checkbook
Identify tax obligations
Analyze how credit affects financial security
Compare types and methods of investments
Compare types and methods of borrowing
Compare types and methods of insurance
Compare types of retirement options/plans
Identify discriminatory vs. non-discriminatory expenditures

Competency: Support community well-being

Competency Builders:

Identify environmental, educational, and social issues
Participate in social and/or community activities

Competency: Achieve organizational goals

Competency Builders:

Evaluate personal goals in relation to organizational goals
Monitor progress by evaluating feedback
List responsibilities in relation to organization goals
Accomplish assigned tasks
Exercise responsibility in relation to organizational goals
Set appropriate personal performance standards
Communicate goals with supervisor and peers
Demonstrate knowledge of products and services
Promote organizational image and mission

Competency: Demonstrate positive relations in the workplace

Competency Builders:

Identify personality types of self and other
Identify various management styles
Support employer expectations
Support employer decisions
Accept constructive criticism
Give constructive feedback
Adapt to changes in workplace
List factors to consider before resigning
Write letter of resignation

Competency: Manage stressful situations

Competency Builders:

Accept stress as part of daily life
Identify personal and professional factors contributing to stress
Describe physical and emotional responses to stress
Evaluate positive and negative effects of stress on productivity
Identify strategies for reducing stress
Implement strategies to manage stress
Create strategies for developing and maintaining support systems

Competency: Analyze effects of family on work and work on family

Competency Builders:

Identify how family values, goals, and priorities are reflected in work place
Identify responsibilities and rewards associated with paid and non-paid work
Identify responsibilities and rewards associated with families
Explain how family responsibilities can conflict with work
Explain how work can conflict with family responsibilities
Explain how work-related stress can affect families
Explain how family-related stress can affect work
Identify family support systems and resources
Identify work-related support systems and resources
Communicate with family regarding work

Competency: Apply lifelong learning skills

Competency Builders:

Define lifelong learning
Identify factors that cause need for lifelong learning
Analyze effects of change
Identify reasons why goals change
Describe importance of flexibility and adaptability
Evaluate need for continuing education/training

Competency: Manage professional development

Competency Builders:

Identify career opportunities
Modify career plan
Participate in continuing education/training opportunities
Document continuing education/training
Read profession-related manuals, technical journals, and periodicals
Attend meetings, workshops, seminars, conferences, and demonstrations
Participate in professional organizations
Build personal/professional mentor relationship
Build personal/professional support system
Build professional network
Strengthen communication skills
Strengthen leadership skills
Strengthen management skills

Unit: Teamwork

Competency: Demonstrate knowledge of teamwork

Competency Builders:

Define empowerment
Differentiate work groups and teams
Identify conditions essential to teamwork (e.g., brainstorming)
Explain influence of culture (e.g., corporate, community) on teamwork
Identify appropriate situations for using teams
Define team structures (e.g., cross functional, quality improvement, task force, quality circles)
Identify team building concepts
Describe characteristics and dynamics of teams
Identify characteristics of effective team leaders and members
Identify responsibilities of a valuable team member
Identify methods of involving each member of a team
Explain how individuals from various backgrounds contribute to work-related situations (e.g., technical training, cultural heritage)
Explain the purpose of facilitators
Define consensus
Define reward/recognition system

Competency: Demonstrate teamwork

Competency Builders:

Identify purpose of team and intended goal (include time frames)
Structure team around purpose
Define responsibilities of team members
Contribute to efficiency and success of team
Work toward individual and team milestones
Analyze results of team project
Facilitate a team meeting
Assist team member(s) with problem
Monitor time frame
Stress continuous improvement
Accept failure as part of learning

Competency: Use teamwork to solve problems

Competency Builders:

Identify appropriate situations for using teams
Use problem-solving process in a team setting
Identify quality management processes/techniques
Identify quality assurance processes/techniques
Prepare presentation

Competency: Conduct team meetings

Competency Builders:

Plan agenda
Schedule meeting and location
Invite appropriate personnel
Solicit outside speakers as needed
Assign someone to take minutes
Facilitate introductions
Invite questions and comments and group participation
Focus team on agenda items
Assign appropriate action, time frame and accountability to tasks
Monitor time
Close meeting on time
Publish minutes in timely manner
Set ground rules
Avoid placing individual agendas above the group's agenda

Unit: Quality Assurance

Competency: Demonstrate knowledge of quality assurance

Competency Builders:

Explain the historical evolution of quality assurance (e.g., Deming, ISO 9000)
Explain changes brought about by quality leaders in the world
Explain the ISO 9000 process
Define quality terms
Define quality functions
Identify features of quality planning
Describe control devices used in functional areas (e.g., SPC, equipment)
Explain the relationship among organizational structures, policies, procedures, and quality assurance
Explain importance of internal and external customers
Identify internal and external customers
Describe successful efforts by industry to improve quality and/or reduce costs
Differentiate prevention and detection
Differentiate variable and attribute data
Identify types of coontrol charts
Explain how statistical techniques are tools used to control quality (e.g., SPC, DOE, CR)

Competency: Demonstrate knowledge of quality cost implications

Competency Builders:

Identify cost/quality objectives
Classify costs (i.e., direct and indirect, fixed and variable, methods and standards)
Classify quality costs (i.e., prevention, evaluation, pre-delivery failure, post-delivery failure)
Define produce liability
Interpret quality cost reports
Explain consumerism and liability prevention
Define safety terms of product
Identify safety responsibility within organization
Define contracts and torts
Differentiate express and implied warranty
Differentiate warranty and product liability
Explain how warranties are part of contract law
List questions that would need answering in liability claim

Competency: Demonstrate knowledge of engineering a quality product

Competency Builders:

Associate customer satisfaction with product characteristics (e.g., usefulness, price, operation, life, reliability, safety, cost of operation)
Define manufacturability
Identify steps in product design (e.g., brainstorming, thumbnail sketches, rendering)
Define reliability factors (e.g., cost, human, producibility)
Identify ways reliability is achieved (e.g., maintainability, good design, design simplification, design redundancy)
Explain the relationship of maintainability to reliability
Define failure
Explain the role of testing and reliability
Define value engineering
Define quality objectives
Identify cost components as they relate to quality objectives
Classify quality costs (i.e. preventive, evaluation, pre-delivery failures, post delivery failures)
Describe predictive maintenance

Competency: **Explain importance of interdepartmental relationships to quality assurance**

Competency Builders:

Explain need for everyone's commitment in assuring quality
Explain phrase "Everyone is a customer/supplier"
Define quality improvement team models
Explain the importance of top management's support of quality
Explain project selection
Explain project implementation
Explain project evaluation
Explain continuing improvement
Describe future trend of experiment design
Describe future trend of predictive maintenance

Competency: **Manipulate quality cost data**

Competency Builders:

Develop quality cost data
Translate cost reports
Graph quality cost data (e.g., pareto)

Competency: **Manipulate cost control data**

Competency Builders:

Develop cost control data
Analyze cost control reports
Provide cost control data
Provide advice on "Make or Buy" decisions (including economical lot size decisions)

Competency: Use quality control charts

Competency Builders:

Identify operational definitions for attribute criteria
Interpret histogram
Interpret scattergrams
Interpret NP chart
Interpret P chart
Interpret flowchart
Interpret cause-and-effect diagram
Construct P (percentage defective) chart for attributes
Plot control limits of P chart and data points
Check chart for out-of-control conditions
Construct an NP (number defective) chart with control limits and data
Construct C (count of defects) and U (number of defects per unit) charts
Check data on C and U charts
Construct flowchart
Construct cause-and-effect chart

Competency: Interpret $\overline{X}$ and R charts

Competency Builders:

Plot percentages for normal distribution
Test distribution for normality
Explain difference between common cause and special cause
Define an "in-control" process
Explain significance of an out-of-control point on $\overline{X}$ or R chart
Identify patterns and trends on control chart
Identify run up and run down
Test for middle third on control chart
Explain significance of middle third on control chart
Explain Rule of Sevens

Competency: Demonstrate knowledge of precontrol

Competency Builders:

Explain uses of precontrol
Calculate precontrol limits
Explain significance of the limits
Plot values on a precontrol chart
Explain "out-of-control" situation
Make decisions on green, yellow and red conditions

Competency: Demonstrate knowledge of process capability

Competency Builders:

Use X, R, USL, and LSL to determine process capability (upper and lower specification limits)
Calculate estimated process standard deviation
Plot right hand and left hand tail of process variation
Compute Z value for percent of probable defect for process
Calculate C_{PK} values that describe process capability
Describe skewed distributions
List probable causes of skewed distribution

Competency: Demonstrate knowledge of JIT

Competency Builders:

Define just-in-time concept (JIT)
Describe various production methodologies (e.g., standard cycle times, routings, standard quantities, multiple-machine tending)
Describe types of inventory control (e.g., Kanban)
Describe importance of flexibility
Differentiate product layout, process layout, fixed position layout, and cellular layout
Differentiate straight-line, U-shaped, S-shaped, convoluted and comb patterns
Describe advantages/disadvantages of layout and patterns
Explain importance of product protection, identification and storage
List methods of identifying products (e.g., labels, bar codes, radio frequency systems and magnetic strip systems)
Describe manual methods of storage and retrieval
Describe automated storage and retrieval systems (ASRS)
Describe automated guided vehicle moving systems (AGVS)

Competency: Apply JIT

Comptency Builders:

Maintain system for physical handling and movement of material in-process and in-storage
Monitor system of physical handling and movement of material in-process and in-storage
Maintain system for physical handling and movement of finished products
Monitor system of physical handling and movement of finished products
Write requests for deviation from specifications
Implement quality control and inspection standards and procedures
Write engineering change notices and rejection reports
Monitor reports of discrepancy or rejects during production process
Conduct quality tests under different environmental conditions

Competency: Construct $\overline{X}$ and R charts

Competency Builders:

Arrange data into statistical sub-groups
Explain importance of random sampling
Compute $\overline{X}$ (i.e., average of values) and R (i.e., range of values in subgroup) within sample
Plot in $\overline{X}$ and R on chart
Construct control chart with $\overline{\overline{X}}$ (grand average) and R (average range) calculated
Calculate upper and lower control limits for $\overline{X}$-chart
Calculate upper and lower control limits for R-chart

Competency: Conduct process improvement studies

Competency Builders:

Analyze production methods and processes applying statistical process improvement techniques (e.g., SPC, C_{PK})
Identify appropriate statistical techniques for study (e.g., T-tests, F-test, capability, DOEX)
Identify major steps in conducting a study
Define "report" for a study (e.g., goal, objective, study conduct, results, conclusions, discussions)
Integrate results into the total system

Competency: Demonstrate knowledge of JIT

Competency Builders:

Define just-in-time concept (JIT)
Describe various production methodologies (e.g., standard cycle times, routings, standard quantities, multiple-machine tending)
Describe types of inventory control (e.g., Kanban)
Describe importance of flexibility
Differentiate product layout, process layout, fixed position layout, and cellular layout
Differentiate straight-line, U-shaped, S-shaped, convoluted and comb patterns
Describe advantages/disadvantages of layout and patterns
Explain importance of product protection, identification and storage
List methods of identifying products (e.g., labels, bar codes, radio frequency systems and magnetic strip systems)
Describe manual methods of storage and retrieval
Describe automated storage and retrieval systems (ASRS)
Describe automated guided vehicle moving systems (AGVS)

Competency: Apply JIT

Comptency Builders:

Maintain system for physical handling and movement of material in-process and in-storage
Monitor system of physical handling and movement of material in-process and in-storage
Maintain system for physical handling and movement of finished products
Monitor system of physical handling and movement of finished products
Write requests for deviation from specifications
Implement quality control and inspection standards and procedures
Write engineering change notices and rejection reports
Monitor reports of discrepancy or rejects during production process
Conduct quality tests under different environmental conditions

Competency: Demonstrate knowledge of inspection

Competency Builders:

Explain purpose of inspection
Describe scope of inspection
Explain purpose of incoming, ongoing, and final inspections
Explain early detection inspection
Explain how statistical process control (SPC) aids inspection
Define types of nonconformance
Define degrees of nonconformance
Define corrective action
Describe when to 100% inspect
Describe when to sample inspect
Describe methods of testing for material properties (e.g., harness, strength, chemical makeup, flaws, errors in tooling or setup)
Define rework, salvage, and scrap
Describe ethical decisions an inspector may make
Identify purposes of computer-automated inspection
Explain advantages and limitations of automated inspection
Explain disposition of non-conforming material
Explain basic foolproofing concept to build inspection into process (i.e., poka-yoke)
Use checksheets to organize and record inspection results

Competency: Inspect machinery, materials, and products

Competency Builders:

Identify critical material characteristics from specification(s) or drawing(s)
Perform capability studies for machinery and materials acceptance
Identify appropriate acceptance sampling plan
Conduct incoming materials inspection using sampling plan criteria
Identify critical in-process characteristics from specification(s) or drawing(s)
Demonstrate basic metrology skills
Conduct in-process inspection
Identify appropriate inspection reports and follow-up
Gauge R and R (reproducibility and repeatability)
Apply geometric tolerancing
Explain C = O (zero) acceptance plan
Interpret instructions in a control plan

Competency: **Demonstrate knowledge of nondestructive testing**

Competency Builders:

Describe purpose of nondestructive testing
Identify anomalies
Define defects and discontinuities
Identify factors contributing to defects and discontinuities
Describe ultrasonic testing
Describe advantages and limitations of ultrasonic testing
Describe industrial radiography
Compare use of wet and dry particles in magnetic particle inspection
Explain advantages and limitations of penetrant inspection
Describe microwave testing
Describe holographic inspection
Explain choice of most suitable nondestructive test method
Describe eddy-current testing

Unit: Technical Recording and Reporting

Competency: Demonstrate proficiency in technical recording

Competency Builders:

Describe various documentation procedures
Interpret specifications or drawings
Observe process
Ask open-ended questions
Record process (e.g., flowchart, step-by-step)
Identify parameters
Record accurate, truthful data
Maintain test logs
Compile cumulative reference notebook/record
Measure appropriate parameters
Draft preventive maintenance and calibration procedures

Competency: Demonstrate proficiency in technical reporting

Competency Builders:

Use data books and cross reference/technical manuals
Compose technical memoranda
Identify type of report or format needed
Use appropriate format
Compile relevant data
Design charts and graphs
Analyze data
Draw conclusions
Explain analytical methods used
Outline reports
Write reports
Present reports

Unit: Computer Literacy

Competency: Describe personal computer operations

Competency Builders:

Explain how data is stored in main computer memory
Explain how computer system executes program instruction
Explain computer storage capacity
Explain how data is represented
Describe data storage techniques
Identify types of memory

Competency: Explain information processing cycle

Competency Builders:

Define operating systems (e.g., DOS, OS/2, UNIX, MAC)
Describe computer languages and their use
Describe computer languages and their use
Describe computer languages and their use
Describe difference between data files and program files
Explain PC layout
Explain PC network layout
Explain mini/mainframe network layout
Differentiate hardware and software
Differentiate open from proprietary architecture

Competency: Operate computer hardware

Competency Builders:

Practice proper media handling techniques (e.g., magnetic fields, dust, liquids)
Identify hardware and its use
Use hardware (e.g., mouse, diskettes, drive, modems, touch screen, printers, digitizers, scanners, cables, protection devices)
Keyboard efficiently
Demonstrate basic care of hardware
Explain need for and application of security levels/procedures
Perform basic hardware troubleshooting
Explain hardware addressing techniques

Competency: Use software

Competency Builders:

Define software types and functions
Describe basic disk operations and care
Perform functions necessary to operate software
List advantages and disadvantages of integrated and dedicated software
Operate system software
Operate diagnostic software
Demonstrate basic proficiency in spreadsheet use
Demonstrate basic proficiency in word processing
Demonstrate basic proficiency in database use
Demonstrate basic proficiency in network use
Demonstrate basic proficiency of utility (e.g., WINDOWS, GUI)
Demonstrate basic proficiency in report writing
Demonstrate system commands
Differentiate ethical use/misuse of software
Describe bulletin boards/electronic mail
Apply security levels/procedures while handling sensitive data
Explain data compression techniques
Explain use and deletion of passwords

Unit: Workplace Safety

Competency: Apply general safety precautions

Competency Builders:

Identify local, state, and federal rules and regulations
Identify personal protective wear and equipment
Identify visual controls (e.g., monitors, read outs)
Identify auditory controls
Identify common sense housekeeping
Interpret hazardous materials notices on containers
Use personal protective wear and equipment
Apply workplace safety rules and procedures
Apply personal safety rules and procedures
Apply workplace organization (e.g., housekeeping)
Apply applicable electrical, mechanical, steam, hydraulic and (e.g., pneumatic safety rules and procedures)
Apply fire safety rules and procedures
Apply hazardous wastes rules and procedures
Apply first aid
Locate (MSDS)
Perform lockout and tagout
Recycle scrap metal, chips, shavings, coolants, solvents, trash, and waste materials
Apply common sense housekeeping
Use preventive maintenance checklists

Competency: **Demonstrate knowledge of safety and workplace hazards**

Competency Builders:

Describe corrective procedures for unsafe conditions
Identify types and potential level of workplace hazards (e.g., physical hazards, fire, chemicals, noise, ionizing radiation, ultraviolet, temperature extremes, ergonomics, biological hazards)
Identify safety materials/equipment (e.g., absorbant socks, oil dry)
Interpret Material Safety Data Sheets (MSDS)
Explain purpose(s) of OSHA and NIOSH
Explain purpose(s) of NEC and NFPA
Identify purpose of emergency evacuation routes, master switch and lockout locations, and safety color coding systems
Identify roles of industrial hygienists, safety professionals, occupational physicians, and occupational nurses
Describe methods of evaluating potential hazards (e.g., visual analysis)
Describe methods of correcting potential hazards
Describe various types of toxicity (e.g., chronic, immediate)
Identify need for reporting accidents
Explain precautions required when using toxic or flammable materials
Define confined space and related requirements
Explain how international directives relate to safety

Competency: **Explain purpose of industrial pollution control systems**

Competency Builders:

Describe types of air, water, solid waste, and noise pollution
Explain purpose of air pollution control systems
Explain purpose of water pollution control systems
Explain purpose of solid waste pollution control systems
Explain purpose of noise pollution control systems
Explain basic philosophy of "right to know" legislation
Explain purpose(s) of EPA
Identify "costs" of industrial pollution control (i.e., dollars vs. impact to environment)
Describe ethics of environmental issues

Competency: Demonstrate knowledge of ergonomics

Competency Builders:

Define ergonomics
Define risk factor
Define maximum permissible limit (MPL) and action limit (AL) for lifting
Define cumulative trauma disorder (CTD)
Identify susceptibility factors for CTD
Minimize extreme joint movement
Minimize use of excessive muscle force
Minimize repetitive tasks
Minimize mechanical stresses (e.g., sharp edges, heat, cold, hard surfaces, weights, vibration)
Minimize awkward body positions
Explain use of rest pauses
Explain need for mats and footrest for standing jobs
Explain need for appropriate working heights of chairs, stools, workbenches, equipment
Explain need for adequate lighting
Explain use of anthropometric (i.e., centering one's view of everything around man) design

Unit: Hydraulics and Pneumatics

Competency: Describe fluid flow concepts

Competency Builders:

Explain Pascal's Law
Explain Boyle's Law
Explain Bernoulli's Principle
Describe flow velocity
Explain how heat and pressure relate to power and transmission
Describe physical and chemical properties of a fluid
Describe fluids in motion in closed conductors
Describe continuity of mass flow
Identify types of fluids
Identify properties of fluids
Identify English and metric units of measurement for pressure, density, and viscosity

Competency: Describe energy considerations

Competency Builders:

Differentiate work and power
Differentiate potential and kinetic energy
Explain energy conservation concept
Explain hydraulic horsepower
Explain work of compression in compressible fluids

Competency: Describe system losses

Competency Builders:

Differentiate turbulent and laminar flow
Explain friction factor
Explain pressure losses
Identify potential system losses (e.g., leaks, wear, component sizing, heat, dirt)

Competency: Describe hydrostatics

Competency Builders:

Explain pressure, density, and viscosity
Explain buoyancy
Explain equilibrium

Competency: Calculate energy

Competency Builders:

Apply Pascal's Law
Apply Bernoulli's Principle
Apply Boyle's Law
Calculate work and power
Calculate potential and kinetic energy
Calculate hydraulic horsepower
Calculate flow velocity and pressure
Calculate pressure losses
Calculate laminar flow
Calculate pump capacity
Calculate system requirements

Competency: Design basic hydraulic/pneumatic system

Competency Builders:

Use common symbols
Create circuit diagrams (i.e., schematics)
Diagram closed-loop hydraulic system
Diagram an air supply system

Competency: Describe component operation

Competency Builders:

Identify functions and operation of hydraulic components
Identify functions and operation of pneumatic components
Explain application(s) of different materials (e.g., plastic, copper)

Competency: Interpret hydraulic and pneumatic schematics

Competency Builders:

Identify common symbols
Sketch circuit diagrams (i.e., schematics)
Interpret circuit diagrams (i.e. schematics)
Sketch circuit analysis
Diagram an air supply system

Competency: Troubleshoot hydraulic and pneumatic circuits

Competency Builders:

Analyze hydraulic circuits
Troubleshoot hydraulic circuits
Analyze pneumatic circuits
Troubleshoot pneumatic circuits

Competency: Perform pump maintenance and repair

Competency Builders:

Identify types and operating features of pumps
Identify pump capacity and system requirements
Explain packing and seal requirements
Explain operating principles of pumps (e.g., centrifugal, propeller and turbine rotary, metering)
Perform pump maintenance
Disassemble a pump
Reassemble a pump

Competency: **Maintain piping and accessories for high and low pressure fluid power systems**

Competency Builders:

Identify components of a piping system
Explain maintenance features of both metallic and non-metallic piping systems
Explain types of values and their operation and maintenance
Explain use and maintenance of strainers, filters, and traps in piping systems
Join common fittings
Join metallic pipe
Join plastic pipe
Join copper and steel tubing
Bend copper and steel tubing
Cut copper and steel tubing
Flare tubing

Competency: **Maintain hydraulic system components**

Competency Builders:

Install a contaminant removal system
Maintain a contaminant removal system
Explain operation and use of heat exchanges
Identify reservoir requirements
Compute hose requirements
Install hydraulic lines
Select control valves and servo-type valves
Install control valves and servo-type valves

Competency: Troubleshoot hydraulic systems

Competency Builders:

Interpret hydraulic schematic
Identify causes of failure modes
Connect electrically controlled valves
Explain hydraulic system troubleshooting techniques
Repair or replace hydraulic valves
Repair or replace hydraulic cylinders
Repair or replace hydraulic pumps and motors
Install hydraulic components

Competency: Describe reciprocating and rotary air compressors

Competency Builders:

Explain relationship of force, weight, mass, and density in pneumatic system
Explain operation of reciprocating compressors
Explain operation of rotary compressors
Explain primary and secondary air treatment (e.g., air dryers, lubricating systems)
Explain operation of compressor valves, cylinders, and motors

Competency: Maintain pneumatic systems

Competency Builders:

Install pneumatic system components
Explain pneumatic system maintenance techniques
Explain pneumatic system troubleshooting procedures
Isolate faults in air compressors
Repair or replace air compressors
Isolate faults in control valves
Repair or replace control valves
Isolate faults in air motors
Repair or replace air motors
Isolate faults in air dryers
Repair or replace air dryers
Maintain proportioning and servo valves

Competency: Troubleshoot pneumatic systems

Competency Builders:

Interpret pneumatic schematic
Diagram an air supply system
Install pneumatic system components
Explain pneumatic system troubleshooting procedures
Troubleshoot air compressors
Troubleshoot pneumatic control valves
Troubleshoot air motors
Troubleshoot air dryers

Competency: **Maintain vacuum systems**

Competency Builders:

Describe characteristics associated with vacuum systems and sub atmospheric pressure
Describe the principles and operation of vacuum gauges
Demonstrate use of vacuum gauges
Repair or replace vacuum gauges
Describe the principles and operation of vacuum pumps
Demonstrate use of vacuum pumps
Repair or replace vacuum pumps
Describe the principles and operation of vacuum controls
Demonstrate use of vacuum controls
Repair or replace vacuum controls

Unit: Basic Moldmaking

Competency: Explain processes for building molds

Competency Builders:

Describe process of making a mold
Describe machinery used in moldmaking
Describe types of metal castings used for molds
Identify types of components used in the forming process (e.g., gibs, core, cavity, slides, heaters)
Identify surface finishes for molds
Identify types of molding materials (e.g., glass, plastic, rubber, die cast, pressware)
Describe the fitting and assembly process

Competency: Describe the process of extrusion

Competency Builders:

Explain extrusion method
Identify machines and dies used in extrusion
Identify applications for extrusion

Competency: Describe compression molding

Competency Builders:

Explain compression molding method
Identify machines and molds used in compression molding
Identify applications for compression

Competency: Describe injection molding

Competency Builders:

Explain injection molding method
Identify machines and molds used in injection molding
Identify applications for injection molding

Competency: Describe blow molding

Competency Builders:

Explain blow molding method
Identify machines and molds used in blow molding
Identify applications for blow molding

Competency: Describe thermoforming

Competency Builders:

Explain thermoforming method
Identify machines and molds used in thermoforming
Identify applications for thermoforming

Competency: Describe rotational molding

Competency Builders:

Explain rotational molding method
Identify machines and molds used in rotational molding
Identify applications for rotational molding

Competency: Describe calendering method

Competency Builders:

Explain calendering method
Identify machines and molds used in calendering
Identify applications for calendering

Competency: Describe foam processes

Competency Builders:

Explain foam processes method
Identify machines and materials used in foam processing
Identify applications for foam processes

Competency: **Describe powder coating**

Competency Builders:

Explain powder coating method
Identify machines and materials used in powder coating
Identify applications for powder coating

Unit: Polymer Technology

Competency: Demonstrate knowledge of plastics manufacturing

Competency Builders:

Explain the history of the plastics industry
List the advantages and disadvantages of plastics
Define terminology used in the plastics and rubber industry
Identify types of plastics
Categorize how each type of plastic is produced and used
Identify sources of raw materials
Identify the families and applications of thermoplastics, thermosets, and rubbers
Define polymers
Classify polymers by physical and chemical properties
Classify polymers by reactions
Classify polymers by processing methods
Identify processing methods
Identify various uses of plastics in relation to the environment
Identify types and uses of additives in plastics production
Explain composition of color

Competency: Demonstrate knowledge of rubber manufacturing

Competency Builders:

Explain history of rubber industry
Compare properties of natural rubber with those of synthetic rubber
Explain how natural rubber is manufactured
Explain vulcanization, mastication, and cure systems
Explain use of compounding ingredients (e.g., carbon blacks, accelerators, fillers, antioxidants)
Explain press and autoclave curing
Explain how synthetic rubber is manufactured (e.g., neoprene, butyl, styrene-butadiene)

Competency: Demonstrate knowledge of basic polymer chemistry

Competency Builders:

Plot the development of atomic theory
Explain the Bohr atomic model
Construct models of atoms, molecules, and macromolecules
Explain carbon-carbon bonding
Explain theory of electron probability
Describe the behavior of electrons in various atoms
Identify atoms and characteristics of the families from the periodic chart
Demonstrate knowledge of molecular weight definitions
Describe intermolecular bonds
Describe various types of primary bonds
Use Lewis Dot structures to represent primary bonding
Describe various types of secondary bonds
Identify basic organize nomenclature and characteristics of those families
Explain the structure of polymers
Describe how to make polymers from corresponding monomers
Explain the polymerization of polyethylene, addition and condensation polymers, and blends and alloys
Explain degradation (e.g., heat, light, oxygen)
Describe the characteristics of polymeric materials

Competency: Describe basic polymer processing

Competency Builders:

Explain melt flow and rheology
Explain physical and chemical properties of blends
Explain compatibilizers
Explain reinforcement with filler and fiber additives
Explain reactive polymer processing
Explain recycling for post consumption
Explain morphology

Unit: Polymeric Testing

Competency: Demonstrate knowledge of polymeric testing

Competency Builders:

List reasons to test polymers
Explain purpose of standards
Identify factors affecting test results
Identify principles of conditioning

Competency: Apply instrumental methods of analysis

Competency Builders:

Explain linear regression and its uses
Explain purposes of instrumental analysis
Explain precision and error analysis
Explain atomic absorption
Use spectroscopic methods
Use thermal analysis methods
Use chromatographic methods
Use microscopy
Use non-destructive testing methods (e.g., acoustic, strain gauges)

Competency: Perform analytical testing of polymeric materials

Competency Builders:

Identify plastics by trade name and heat reaction
Analyze products by functional requirements
Describe plastics by appearance
Identify plastics by reaction to solvents
Dissect products
Test amorphous and crystalline plastics
Flame test plastics
Identify the burning rates of plastics
Identify the softening point of plastics
Deformation test plastics
Identify specific gravity determinations
Identify specific gravity using density gradient
Identify specific gravity using Jolly Balance
Calculate particle size
Use Melt Index
Identify ash content of thermosetting plastics
Test to document effects of additives on plastics
Extract plasticziers from polyvinyl chloride

Competency: Test polymeric materials for hardness and impact

Competency Builders:

Identify principles of hardness testing
Perform failure analysis
Use shore A & D Durometers
Test with Clark hardness tester
Define the Law of Conservation of Energy
Use Charpy/Izod Impact tester
Perform permeation testing
Identify principles of falling dart impacting
Use Film Dart Impact tester
Perform creep and creep-rupture testing
Explain use of abrasion and friction testing

Competency: Tensile test polymeric materials

Competency Builders:

Explain polymer stress and strain
Use tensometer
Use rheometer
Identify modules of elasticity
Use tear tester
Test for stiffness and resilience of polymeric materials

Competency: Describe effects of weathering and aging on polymeric materials

Competency Builders:

Explain the purpose of weathering/aging tests
Explain the theory of accelerated testing
Perform water absorption tests
Explain water absorption properties of plastics
Explain thermal expansion of plastics
Compare test results performed under different laboratory conditions

Unit: Polymer Extrusion and Molding

Competency: **Describe thermoplastic melting, flow, and solidification**

Competency Builders:

Characterize thermal processing
Define softening and melting
Characterize amorphous and crystalline plastics

Competency: **Apply extrusion method**

Competency Builders:

Explain extrusion method
Identify machines and dies used in extrusion
Conduct extrusion method experiment

Competency: **Apply compression molding method**

Competency Builders:

Explain compression molding method
Identify machines and molds used in compression molding
Conduct compression molding experiment

Competency: **Apply injection molding method**

Competency Builders:

Explain injection molding method
Identify machines and molds used in injection molding
Conduct injection molding experiment

Competency: Apply blow molding method

Competency Builders:

Explain blow molding method
Identify machines and molds used in blow molding
Conduct blow molding experiment

Competency: Apply thermoforming method

Competency Builders:

Explain thermoforming method
Identify machines and molds used in thermoforming
Conduct thermoforming experiment

Competency: Apply rotational molding method

Competency Builders:

Explain rotational molding method
Identify machines and molds used in rotational molding
Conduct rotational molding experiment

Competency: Apply calendering method

Competency Builders:

Explain calendering method
Identify machines and molds used in calendering
Conduct calendering experiment

Competency: Apply foam processes method

Competency Builders:

Explain foam processes method
Identify machines and materials used in foam processing
Conduct foam processes experiment

Competency: Apply powder coating method

Competency Builders:

Explain powder coating method
Identify machines and materials used in powder coating
Conduct powder coating experiment

TECH PREP

"GET SERIOUS . . . ABOUT SUCCESS"

Quality Control Technician

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—NOTICE—

Each Tech-Prep Competency Profile developed should respond to the labor market demands of your Tech Prep Consortium. Therefore, the following pages should be examined carefully before being selected for use in TCP Part I. **[See "The TCP Process" for more information.]** For example, in some cases the number of units far exceeds the amount of content that can be covered within a 4 + 2 TPAD Program. All the units listed in this section will not necessarily apply to your situation, nor will all the competencies within each unit be appropriate. Note that several units appear within each specific occupation and would need to only appear once if you are compiling a cluster of occupations. **[See "TCP Matrix" and "How to Use the TCP Binder" for more information.]**

Unit: Communications Literacy

NOTE: This content was extracted from the 9-12 cluster of Ohio's Model Language Arts Program. Due to statewide initiatives other than Tech Prep, this literacy unit was not altered to meet competency-based criteria. Each literacy unit forms a critical link between academic teachers and members of business, industry, and labor. [See "The TCP Process" for more information.]

Subunit: Reading—Structure

Competencies:

RS1 Exhibit knowledge of language structure
RS2 Recognize that there may be more than one interpretation of reading selections
RS3 Recognize various literary devices
RS4 Recognize and discuss literary elements
RS5 Develop and use an increasingly sophisticated vocabulary gained through context
RS6 Apply knowledge of language structure to reading
RS7 Explain why there may be more than one interpretation of reading selections
RS8 Recognize effect of literacy devices on meaning
RS9 Analyze author's use of literary elements
RS10 Recognize relationship of structure to meaning
RS11 Describe various interpretations and meaning levels in reading selections
RS12 Characterize author's use of literary devices
RS13 Characterize use of literary techniques
RS14 Critique a variety of literature with regard to plot, dialogue, theme, setting, and characterization
RS15 Apply an expanding vocabulary gained through reading
RS16 Explain various interpretations and meaning levels in reading selections
RS17 Analyze use of literary techniques (e.g., extended metaphor, simile, personification, hyperbole, pun, alliteration)
RS18 Understand use of literary devices (e.g., irony, satire, allegory, onomatopoeia)
RS19 Analyze and synthesize pieces of literature with regard to plot, dialogue, theme, setting, and characterization

Subunit: Reading—Meaning Construction
Competencies:

RM1	Demonstrate ability to recognize appropriate pre-reading strategies
RM2	Describe effectiveness of a reading selection
RM3	Read to clarify personal thinking and knowledge
RM4	Support interpretation of text by locating and citing specific information
RM5	Develop personal response to a variety of literary works
RM6	Recognize diverse literary interpretations
RM7	Engage in self-selected reading activities
RM8	Confirm and extend meaning in reading by researching new concepts and facts
RM9	Self-monitor and apply corrective strategies when communication has been interrupted or lost
RM10	Use features of literary genres to extend meaning
RM11	Assess effectiveness of a selection read
RM12	Use reading as a possible problem-solving strategy to clarify personal thinking and knowledge
RM13	Use knowledge of semantic elements (e.g., figurative language, denotation, connotation, dialect) to clarify meaning when reading
RM14	Predict, recognize, interpret, and analyze themes based on familiarity with author's work
RM15	Compare and contrast literary genres
RM16	Assess validity and quality of selection read
RM17	Clarify meaning when reading
RM18	Compare personal reaction to critical assessment of a literary selection
RM19	Assess validity of diverse literary interpretations
RM20	Use reference books to find, evaluate, and synthesize information
RM21	Identify tone of a literary work
RM22	Critique validity of diverse literary interpretations
RM23	Integrate personal reaction to and critical assessment of a literary selection

Subunit: Reading—Application

Competencies:

RA1	Select and read material for personal enjoyment and information
RA2	Read a variety of complete, unabridged works
RA3	Employ various reading strategies according to purpose
RA4	Participate in selection of books, materials, and topics for literature study groups
RA5	Develop and apply knowledge of the interrelationship of concepts
RA6	Read selections from a variety of styles and formats, recognizing that style and format influence meaning
RA7	Extend value of reading, writing, speaking, viewing, and listening by pursuing, through reading, new concepts and interests developed as a result of these activities
RA8	Read extensively from a particular author's work and explain elements
of	author's style

Subunit: Reading—Multidisciplinary

Competencies:

RM1	Connect themes and ideas across disciplines through literature
RM2	Read to facilitate learning across curriculum
RM3	Read to develop awareness of human rights and freedom
RM4	Participate actively in a community of learners
RM5	Recognize and explain interaction between literature and various cultural domains (e.g., social technological, political, economic)
RM6	Explore and analyze a variety of cultural elements, attitudes, beliefs, and value structures by men and women of many racial, ethnic, and cultural groups
RM7	Value thinking and language of others
RM8	Relate literature to historical period about which or in which it was written
RM9	Read to facilitate content learning

Subunit: Writing—Structure
Competencies:

WS1	Develop and expand a repertoire of organizational strategies (e.g., narration, comparison/contrast, and description) through a practice and discussion
WS2	Clarify word choice according to audience, topic, and purpose
WS3	Locate and correct errors in usage, spelling, and mechanics using a variety of resources
WS4	Recognize information gained from primary and secondary sources
WS5	Develop writing which contains ordered, related, well-developed paragraphs with sentences of varied lengths and patterns
WS6	Use information from a variety of sources to develop an integrated piece of writing
WS7	Evaluate and revise writing to focus on such things as audience, tone, and purpose
WS8	Recognize differences between documentation and reference list styles
WS9	Develop extended pieces of writing which contain ordered, related, well-developed paragraphs with sentences of varied lengths and patterns
WS10	Select from a repertoire of organization strategies a pattern appropriate to a topic
WS11	Synthesize information from a variety of sources
WS12	Refine word choice and tone according to audience, situation, and purpose
WS13	Appropriately cite information gained from primary and secondary sources
WS14	Use style manuals or software to prepare documentation and reference lists
WS15	Develop effectively organized pieces of expository writing containing strong voice, clear thesis, and well-developed ideas
WS16	Identify organization patterns appropriate to writing topic
WS17	Respond to others' suggested revisions to a writing piece

Subunit: Writing—Meaning Construction
Competencies:

WM1 Demonstrate knowledge of the recursive nature of the writing process by applying it appropriately to various topics, situations, and audiences
WM2 Develop criteria for writing evaluation using scoring guides and peer/teacher assistance to clarify meaning
WM3 Respond to others' suggested revisions to a piece of writing
WM4 Use word processing, graphics, and publishing aids to construct meaning in writing
WM5 Engage in self-initiated writing activities
WM6 Incorporate personal criteria with generally accepted standards for writing evaluation
WM7 Evaluate, analyze, and synthesize information for writing
WM8 Evaluate own writing using personal and established scoring criteria
WM9 Assess personal/peer revisions to a writing piece
WM10 Recognize and refine personal writing styles

Subunit: Writing—Application
Competencies:

WA1	Apply appropriate writing techniques suitable for varied writing tasks
WA2	Use sentence-combining techniques to improve syntactic fluency and maturity
WA3	Write in response to prompted and self-selected topics in practical, persuasive, descriptive, narrative, and expository domains
WA4	Develop personal voice in writing
WA5	Consider audience and purpose for writing
WA6	Develop criteria for selection and potential development of topic
WA7	Write in a journal or learning log to clarify personal thinking and knowledge
WA8	Apply an expanding vocabulary gained through writing
WA9	Make judicious use of reference sources (e.g., dictionary, thesaurus, on-lien data base, encyclopedia)
WA10	Demonstrate, an appreciation for aesthetically pleasing language through word choice and style
WA11	Apply revising and editing strategies needed for writing task
WA12	Vary sentence lengths and patterns
WA13	Refine personal voice in writing
WA14	Vary styles and formats for intended purpose and audience
WA15	Apply criteria for selection and development of topic
WA16	Participate in peer review of writing in progress
WA17	Use transitions between sentences, ideas, and paragraphs in writing
WA18	Revise and edit papers extensively in preparation for presentation/publication
WA19	Develop a variety of genres
WA20	Focus writing and tone on such elements as audience, situation, and purpose
WA21	Develop topic fully and appropriately
WA22	Use writing process to clarify personal thinking and knowledge
WA23	Apply appropriate recursive writing process as suggested by writing task and writer's process
WA24	Develop an extended piece of writing
WA25	Revise writing and tone to assure focus on such elements as audience, situation, and purpose
WA26	Use writing process to write reflectively

Subunit: Writing—Multidisciplinary

Competencies:

WM1	Use writing process for learning across curriculum
WM2	Use writing process to demonstrate knowledge of need for human rights and freedom
WM3	Value and apply collaborative skills in writing process
WM4	Write in response to reading, speaking, viewing, and listening
WM5	Use multidisciplinary resources in writing projects
WM6	Use writing process to facilitate learning across curriculum
WM7	Recognize value of and engage in collaboration in writing process
WM8	Use communication processes to develop a published writing piece in collaboration with others
WM9	Record experiences and observations related to content learning
WM10	Apply collaborative skills in writing process
WM11	Write collaboratively with peers
WM12	Use cross-disciplinary resources in writing projects

Subunit: Listening/Visual Literacy—Structure

Competencies:

LS1	Listen to and view a wide variety of genres
LS2	Become aware of an author's style through listening and viewing a variety of works
LS3	Recognize correct and appropriate grammar, diction, and syntax
LS4	Expand vocabulary through listening to and viewing varied media
LS5	Recognize beauty of language
LS6	Enhance recognition of an author's style through listening and viewing a variety of works
LS7	Recognize use and misuse of language in media
LS8	Refine knowledge of style through listening and viewing multiple works by the same author
LS9	Expand and refine grammar, diction, and syntax through listening
LS10	Compare authors' styles through viewing and listening to their works
LS11	Expand knowledge of complex grammar, diction, and syntax issues

Subunit: Listening/Visual Literacy—Meaning Construction

Competencies:

LM1	Develop critical thinking skills necessary to evaluate media and assess oral presentations
LM2	Compare new oral texts to past experiences and knowledge in order to enhance comprehension
LM3	Recognize how rhythmic patterns, silence, and cadences enhance quality of speech and literature
LM4	Focus listening and viewing on themes and/or plots
LM5	Gather information from listening and viewing experiences to enhance research
LM6	Use critical thinking skills to evaluate media and oral presentations
LM7	Use prior knowledge and experiences to facilitate comprehension of new oral texts
LM8	Identify rhythmic and time patterns in speech and literature
LM9	Identify and analyze themes and/or plots when listening and viewing
LM10	Use information gathered from listening and viewing experiences to expand research
LM11	Enhance use of critical thinking skills to evaluate media and oral presentations
LM12	Consider prior knowledge and experiences when attempting to understand the meaning of new texts
LM13	Appreciate rhythmic and time patterns of speech and literature
LM14	Select viewing and listening materials to support written text
LM15	Evaluate media and oral presentations analytically and critically
LM16	Organize prior knowledge and experiences to comprehend new texts
LM17	Organize and use viewing and listening materials to support written text

Subunit: Listening/Visual Literacy—Application

Competencies:

LA1	Listen attentively during oral reading
LA2	Use media as stimuli for learning and thinking
LA3	Develop knowledge of structure through art, music, and literature
LA4	Use electronic media to enhance and highlight language learning
LA5	Listen and view for entertainment and enjoyment
LA6	Use technology and other media as means of expressing ideas

Subunit: Listening/Visual Literacy—Multidisciplinary
Competencies:

LM1	Facilitate learning across curriculum through critical listening and viewing
LM2	Engage in individual, small-group, and whole-group listening and viewing activities
LM3	Develop language arts (e.g., viewing, listening) projects collaboratively
LM4	Investigate language and cultural differences through listening and viewing activities
LM5	Participate in a community of learners through productive listening

Subunit: Oral Communication—Structure
Competencies:

OS1	Refine oral communication skills
OS2	Demonstrate knowledge of grammar, usage, and syntax when presenting
OS3	Select topics and vocabulary suitable to audience
OS4	Organize notes and ideas for speaking
OS5	Use language imaginatively
OS6	Modulate voice to meaning when interpreting literature orally
OS7	Organize notes and ideas for formal, semiformal and informal presentations of information
OS8	Refine speaking techniques for formal, semiformal, and informal settings
OS9	Develop repertoire of organizational strategies for presenting information orally
OS10	Expand vocabulary to fit topic
OS11	Select topics suitable to audience, situation, and purpose
OS12	Select appropriate strategies when organizing notes and ideas for speaking

Subunit: Oral Communications—Meaning Construction

Competencies:

OM1	Make connections between prior knowledge and new information for oral presentations
OM2	Participate in informal speaking activities
OM3	Use interviewing techniques to gather information
OM4	Communicate orally to entertain and to inform
OM5	Participate in group communication activities
OM6	Take and organize notes when preparing speech/presentation
OM7	Interpret texts orally to illustrate meaning
OM8	Respond to needs of various audiences
OM9	Gather and assess information for speaking
OM10	Communicate orally to inform and persuade
OM11	Prepare and deliver formal speech/presentation
OM12	Participate in a variety of oral interpretations
OM13	Assess needs of audience and adjust language and presentation according to their knowledge
OM14	Analyze and synthesize information for speaking
OM15	Describe effectiveness of literary selection
OM16	Describe topic or idea in order to clarify personal/audience thinking
OM17	Analyze and synthesize information gathered from a variety of sources for speaking
OM18	Describe validity and/or quality of a literary selection and justify selection
OM19	Interpret orally a variety of literature
OM20	Describe topic or idea to clarify meaning for others

Subunit: Oral Communication—Application

Competencies:

OA1	Become proficient at using interviewing techniques
OA2	Give an oral interpretation for a specific audience
OA3	Develop and apply oral communication skills for cooperative/collaborative learning
OA4	Use oral communication for a variety of purposes and audiences (e.g., negotiations, book reviews, rationales)
OA5	Develop and apply decision-making strategies
OA6	Practice interviewing techniques
OA7	Apply interviewing techniques to purposeful interviews
OA8	Focus oral interpretation on a specific audience

Subunit: Oral Communications—Multidisciplinary

Competencies:

OM1	Value thinking and language of others
OM2	Develop oral projects collaboratively
OM3	Be involved in individual, small-group, and whole-group language activities
OM4	Participate actively in a community of learners
OM5	Investigate language and cultural differences through oral language activities

Unit: Mathematics Literacy

NOTE: This content was extracted from the 9-12 cluster of Ohio's Model Mathematics Program. Due to statewide initiatives other than Tech Prep, this literacy unit was not altered to meet competency-based criteria. Each literacy unit forms a critical link between academic teachers and members of business, industry, and labor. [See "The TCP Process" for more information.]

Subunit: Numbers and Number Relations
Competencies:

NR1	Compare, order, and determine equivalence of real numbers
NR2	Estimate answers, compute, and solve problems involving real numbers
NR3	Compare and contrast real number system, rational number system, and whole number system
NR4	Extend knowledge to complex number system and develop facility with its operation

Subunit: Measurement
Competencies:

M1	Estimate and use measurements
M2	Understand need for measurement and probability that any measurement is accurate to some designated specification
M3	Understand and apply measurements related to power and work
M4	Understand and apply measurement concepts of distance-rate-time problems and acceleration problems
M5	Use real experiments to investigate elasticity, heat, sound, electricity, magnetism, light, acceleration, velocity, energy, and gravity
M6	Use real-world problem situations involving mass and weight
M7	Use real-world problem situations involving simple harmonic motion
M8	Establish ratios with and without common units
M9	Construct and interpret maps, tables, charts, and graphs as they relate to real-world mathematics
M10	Understand and solve rate-change problems
M11	Understand and solve right triangle relationships as they relate to measurement, specifically to Pythagorean theorem
M12	Graph and interpret ordered pairs
M13	Compute total sales from a variety of items
M14	Comprehend and compute rates of growth or decay
M15	Comprehend, compute, and interpret real problems involving annuities

Subunit: Measurement (continued)
Competencies:

M16	Develop an ability to identify real problems and provide possible solutions
M17	Express and apply different types of measurement scales
M18	Identify area and volume

Subunit: Estimation and Mental Computation
Competencies:

E1	Use estimation to eliminate choices in multiple-choice tests
E2	Use estimation to determine reasonableness of problem situations in a wide variety of applications
E3	Estimate shape of graphs of various functions and algebraic expressions
E4	Use mental computation when computer and calculator are inappropriate

Subunit: Data Analysis and Probability
Competencies:

D1	Organize data into tables, charts, and graphs
D2	Understand and apply measures of central tendency, variability, and correlation
D3	Use curve fitting to predict from data
D4	Use experimental or theoretical probability, as appropriate, to represent and solve problems involving uncertainty
D5	Use computer simulations and random number generators to estimate probabilities
D6	Test hypotheses using appropriate statistics
D7	Read, interpret, and use tables, charts, and graphs to identify patterns, note trends, draw conclusions, and make predictions
D8	Identify probabilities of events involving unbiased objects
D9	Use sampling and recognize its role in statistical claims
D10	Design a statistical experiment to study problem, conduct experiment, and interpret and communicate outcomes
D11	Describe normal curve in general terms and use its properties
D12	Create and interpret discrete probability distributions
D13	Understand concept of random variable
D14	Apply concept of random variable to generate and interpret probability distributions, including binomial, uniform, and chi square

Subunit: Algebra
Competencies:

A1 Describe problem situations by using and relating numerical, symbolic, and graphical representations
A2 Use language and notation of functions in symbolic and graphing settings
A3 Recognize and use equivalent zeros of a function, roots and the solution of an equation in terms of graphical and symbolic representations
A4 Describe and use logic of equivalence in working with equations, inequalities, and functions
A5 Develop graphical techniques of solution for problem situations involving functions
A6 Explore and describe characterizing features of functions
A7 Make arguments and proofs in algebraic settings
A8 Factor difference of two squares
A9 Identify slope, midpoint, and distance
A10 Explore and combine rational functions
A11 Explore factoring techniques
A12 Solve quadratic equations by factoring and formula
A13 Set up and solve linear equations
A14 Solve systems of linear equations with two variables
A15 Describe geometric situations and phenomena using variables, equations, and functions
A16 Describe measures of central tendency, mean, median, mode, and variance algebraically and graphically
A17 Represent inequalities on number line and in coordinate plane
A18 Use coordinate arguments in making geometric proofs
A19 Symbolize transformations of figures and graphs
A20 Explore geometric basis for functions of trigonometry
A21 Graph linear functions
A22 Develop and use vectors to represent direction and magnitude including operations
A23 Use polar and parametric equations to describe, graph, and solve problem situations
A24 Represent sequences and series as functions both algebraically and graphically
A25 Explore recursive functions and procedures using spreadsheets, other computer utilities, and appropriate notions
A26 Describe and solve algebraic situations with matrices
A27 Describe and use inverse relationship between functions including exponential and logarithmic

Subunit: Algebra (continued)
Competencies:

A28 Analyze and describe errors and error sources that can be made when using computers and calculators to solve problems
A29 Decide whether problem situation is best solved using computer, calculator, paper and pencil, or mental arithmetic/estimation techniques
A30 Explore relationships between complex numbers and vectors
A31 Make arguments concerning limits, convergence and divergence in context involving sequences, series, and other types of functions
A32 Represent transformations in plane with matrices
A33 Contrast and compare algebra's of rational, real, and complex numbers with characteristics of a matrix algebra system
A34 Construct polynomial approximations of a function over specified intervals of convergence
A35 Examine complex numbers as zeros of functions
A36 Translate verbal statements into symbolic language
A37 Simplify algebraic expressions
A38 Use laws and exponents (including scientific notation)
A39 Expand and extend idea of vectors and linear algebra to higher dimensional situations
A40 Use the idea of independent basis elements for a vector space and associated fundamental concepts of finite dimensional linear algebra
A41 Develop and communicate arguments about limit situations
A42 Use matrices to describe and apply transformations
A43 Develop and use polar and parametric equations to represent problem situations
A44 Explore proofs by mathematical induction

Subunit: Geometry
Competencies:

G1	Create and interpret drawings of three-dimensional objects
G2	Represent problem situations with geometric models and apply properties of figures
G3	Apply Pythagorean theorem
G4	Demonstrate knowledge of angles and parallel and perpendicular lines
G5	Explore inductive and deductive reasoning through applications to various subject areas
G6	Translate between synthetic and coordinate representations
G7	Identify congruent and similar figures using transformation with computer programs
G8	Deduce properties of figures using transformations and coordinates
G9	Use deductive reasoning
G10	Explore compass and straightedge constructions in context of geometric theorems
G11	Demonstrate knowledge of and ability to use proof
G12	Use variety of proof techniques (e.g., synthetic, transformational, and coordinate)
G13	Use variety of proof formats, including T-proof (i.e., two-column) and paragraph proof
G14	Explore different proof strategies
G15	Investigate different proofs of theorems
G16	Develop knowledge of an axiomatic system
G17	Apply transformations and coordinates in problem solving
G18	Represent problem situations with geometric models and apply properties of figures
G19	Deduce properties of figures using vectors
G20	Analyze properties of Euclidean transformations and relate translations to vectors
G21	Apply vectors in problem solving
G22	Develop further knowledge of axiomatic systems by investigating and comparing various geometry's

Subunit: Patterns, Relations, and Functions
Competencies:

P1	Model real-world phenomena with polynomial and exponential functions
P2	Explore relationship between zeros and intercepts of functions
P3	Translate among tables, algebraic expressions, and graphs of functions
P4	Use graphing calculator or computer to generate graph of a function
P5	Explore relationship between a linear function and its inverse
P6	Describe and use characteristics of polynomial functions in problem-solving situations
P7	Explore conic sections and graph using graphing calculator or computer
P8	Apply trigonometric functions to problem situations involving triangles
P9	Discover relationships between algebraic description, kind, and properties of conic
P10	Explore periodic real-world phenomena using sine and cosine functions
P11	Analyze effects of parameter changes on graphs
P12	Use graphing calculator or computer to graph functions
P13	Develop an knowledge of rational and transcendental functions
P14	Understand connections between trigonometric and circular functions
P15	Use circular functions to model periodic real-world functions
P16	Solve trigonometric equations and verify trigonometric identities
P17	Understand connections between trigonometric, exponential, and logarithmic functions and polar coordinates, complex numbers, and series
P18	Model real-world phenomena with a variety of functions
P19	Graph using polar coordinates
P20	Explore graphs in three dimensions
P21	Explore functions of several variables
P22	Explore recursive functions using spreadsheets and/or programming languages

Unit: Science Literacy

NOTE: This content was extracted from the 9-12 cluster of Ohio's Draft Model Science Program. Due to statewide initiatives other than Tech Prep, this literacy unit was not altered to meet competency-based criteria. Each literacy unit forms a critical link between academic teachers and members of business, industry, and labor. [See "The TCP Process" for more information.]

Subunit: Scientific Inquiry

Competencies:

Q1 Check the appropriateness and accuracy of measures and computations using various strategies (e.g., estimations, unit analysis, determination of significant figures)
Q2 Use ratios, proportions, and probabilities in appropriate problem situations
Q3 Translate information from and represent information in various forms with equal ease (e.g., tables, charts, graphs, diagrams, geometric figures)
Q4 Use existing algebraic formulas and create new ones in appropriate problem-solving situations
Q5 Estimate and justify probabilities of outcomes of familiar situations based on experimentation and other strategies
Q6 Invent apparatus and mechanical tools needed to perform unique tasks in various situations
Q7 Identify, compare, and contrast different modes of inquiry, habits of mind, and attitudes and dispositions
Q8 Design investigations that are safe and ethical (i.e., obtain consent and inform others of potential outcomes, risks and benefits, and show evidence of concern for human health and safety, concern for non-human species)
Q9 Make and read scale drawings, maps, models, and other representations to aid planning and understanding
Q10 Seek elaboration and justification of data and ideas, and reflect on alternative interpretations of the information
Q11 Use appropriate units for counts and measures
Q12 Create and use databases (electronic and other) to collect, organize, and verify data and observations
Q13 Design and conduct investigations with multiple variables
Q14 Communicate the results of investigations clearly in a variety of situations

Subunit: Scientific Inquiry (continued)
Competencies:

Q15 Examine relationships in nature, offer alternative explanations for the observations, and collect evidence that can be used to help judge among explanations

Q16 Trace the development (e.g., history, controversy, and ramifications) of various theories, focusing on supporting evidence and modification with new evidence

Q17 Select, invent, and use tools, including analog and digital instruments, to make and record direct measurements

Q18 Observe and document events and characteristics of complex systems

Q19 Explain the influence of perspective (e.g., spatial, temporal, and social) on observation and subsequent interpretations

Q20 Create multiple representations of the same data using a variety of symbols, descriptive languages, mathematical concepts, and graphic techniques

Q21 Generate testable hypotheses for observations of complex systems and interactions

Q22 Document potentially hazardous conditions and associated risks in selected homes and public areas

Q23 Participate in public debates, relying on documented and verified data to construct and represent a position on scientific issues

Q24 Construct and test models of physical, biological, social, and geological systems

Q25 Read, verify, debate, and, where necessary, refute research published in popular or technical journals of science (e.g., *Discover*, *Omni*, *Popular Mechanics*)

Q26 Explore discrepant events and develop and test explanations of what was observed

Q27 Conduct theory-based research using surveys, observational instruments, and other methods

Q28 Modify personal opinions, interpretations, explanations, and conclusions based on new information

Q29 Analyze error and develop explanations in various domains

Q30 Formulate taxonomic schemes based upon multivariate models that help to explain similarities and differences in form, distribution, behavior, survival, and origin of objects and organisms

Q31 Demonstrate various logical connections between related concepts (e.g., entropy, conservation of energy)

Q32 Account for discrepancies between theories and observations

Q33 Analyze the changes within a system when inputs, outputs, and interactions are altered

Subunit: Scientific Inquiry (continued)
Competencies:

Q34	Create, standardize, and document procedures
Q35	Determine the sources of significant disparities between the predicted and recorded results and change research procedures to minimize disparities
Q36	Research, locate, and propose applications for abstract patterns (e.g., fractals, Fibonacci sequences, string theory, orbitals)
Q37	Recognize and utilize classification systems for particles, elements, compounds, phenomena, organisms, and others for exploring and predicting properties and behaviors
Q38	Suggest and defend alternative experimental designs and data explanations (e.g., sampling, controls, safeguards)
Q39	Recognize and communicate differences between questions that can be investigated in a scientific way and those that rely on other ways of knowing
Q40	Draw conclusions based on the relationships among data analysis, experimental design, and possible models and theories
Q41	Suggest new questions as a result of reflection on and discussions about their own scientific investigations
Q42	Investigate, assess, and comment on strengths and weakness of the descriptive and predictive powers of science
Q43	Create new information from representations of data in a variety of forms (e.g., symbols, descriptive languages, graphic formats) utilizing a variety of techniques (e.g., interpolations, extrapolations, linear regressions, central tendencies, correlation's)

Subunit: Scientific Knowledge
Competencies:

K1 Investigate various types of dynamic equilibrium (e.g., biological, geological, mechanical, chemical)

K2 Investigate the relationship between the rates of energy exchange and the relative energy level of components with systems (e.g., tropic levels of ecosystems, osmosis, rate of heating and cooling, storms)

K3 Investigate patterns in the natural world (e.g., heredity, crystalline structures, population and resource distributions, diffraction, dispersion, polarization)

K4 Investigate models and theories that help to explain the interactions of components in systems (e.g., conservation of mass, energy, and momentum; food webs; natural selection; entropy; plate tectonics; chaos; relativity; social-psychology)

K5 Investigate degrees of kinship among organisms and groups of organisms

K6 Investigate the limits of the definition of life, and investigate organisms and physical systems that exist at or near these limits (e.g. viruses, quarks, black holes)

K7 Investigate estimates and measurements of a wide range of distances and rates of change

K8 Investigate the historical development of theories of change over time (e.g., natural selection, continental drift, the big bang, geologic change)

K9 Investigate physical and chemical changes in living and non-living systems (e.g., photosynthesis, weathering processes, glaciation, thermal effects of materials, energy cells)

K10 Investigate simulations of nuclear change (e.g., radioactivity, half life, carbon dating)

K11 Investigate conservation principles associated with physical, chemical, and nuclear changes

K12 Formulate descriptions of the impacts of various forms of mechanical and electromagnetic waves on various organisms on each other over time

K13 Formulate models and hypotheses for patterns in the natural world (e.g., earth structures, transportation systems, migrations, communications, constellations)

K14 Formulate explanations for the influences of objects and organisms on each other over time

K15 Formulate and interpret explanations for change phenomena (e.g., mass extinction's, stellar evolution, punctuated equilibrium, molecular synthesis)

Subunit: Scientific Knowledge (continued)
Competencies:

K16 Formulate and interpret explanations for the magnitudes of diversity at different periods of geologic time (e.g., mutation, global cataclysms, continental drift, competition, mass extinction's)

K17 Formulate interpretations of the structure, function, and diversity in a variety of organisms and physical systems (e.g., DNA and RNA variants, nucleons, interaction particles)

K18 Formulate understandings of geologic time (e.g., millennia, periods, epochs)

K19 Formulate an understanding of the historical development of the model of the universe

K20 Formulate explanations and representations of the production, transmission, and conservation of energy in biological and physical systems (e.g., weather, volcanism, earthquakes, electricity, magnetism, cellular respiration)

K21 Formulate models and hypotheses about patterns in the natural world (e.g., social behavior, molecular structure, energy transformation, entropy, randomness, aging, chaos, hormonal cycles)

K22 Formulate interpretations of the relationship between energy exchange and the interfaces between components within systems

K23a Formulate estimations for the range of energies within and between various phenomena (e.g., thermal, electromagnetic, thermonuclear, chemical, electrical)

K23b Formulate explanations for the historical development of descriptions of motions interactions and transformations of matter and energy (e.g., classical Newtonian mechanics, special and general relativity, chaos)

K24 Formulate models that can be used to describe fundamental molecular interactions in living and non-living systems (e.g., cell membranes, semiconductors).

K25 Formulate an understanding of the degree of relationship among organisms and objects based on molecular structure (e.g., proteins, nucleic acids)

K26 Formulate hypotheses and models that may account for observable events (e.g., electricity and magnetism, gravitation, atoms, bonding, chemical reactions, quantum effects, energy flow on biological systems, predator-prey relationships)

K27 Formulate models and hypotheses about change over time (e.g., natural selection, speciation, punctuated equilibrium, phyleytic gradualism, stellar evolution, plate tectonics, radioactive decay, quantum mechanical theory)

Subunit: Scientific Knowledge (continued)
Competencies:

K28 Formulate lists of limitations and propose refinements of standard classification systems (e.g., periodic table, IUPAC, Linnean, standard model)

K29 Formulate specific cases of limitations and possible exceptions of theories and principles regarding the interactions of moving objects and organisms (e.g., fluid flow in vessels, motion near the speed of light, Heisenberg uncertainty principle, meteorological prediction, local variation and diversity, predicting earthquakes, energy transport in cellular respiration)

K30 Formulate plans and contingencies that can be used to accommodate for changes to and stresses on systems (e.g., wildlife and habitat management, corrosion prevention, noise abatement, structure design)

K31 Formulate models of molecular, atomic, ionic, and subatomic structures and the physical and biological implications of these structures (e.g., genes, nucleons, quarks)

K32 Formulate estimates for a wide range of measurements and scales (e.g., angstroms to light years)

K33 Formulate and interpret representations of time from origin to present accounting for phenomena of scale (e.g., smoothness, punctuation's, chaos)

K34 Formulate interpretations of the historical development of various theories of possible causes of diversity among physical and biological phenomena (e.g., the works of Aristotle, Mendel, Darwin, McClintock)

K35 Formulate models and hypotheses that can be used to explain the interactions of components within technological and ecological systems

Subunit: Conditions for Learning Science

Competencies:

C1 Participate actively in dialogue about and resolution of community issues
C2 Assess information from various countries in the original language or translated form to ascertain the perspectives of many cultures
C3 Analyze the scientific ideas presented in science fiction stories and films
C4 Perform and repeat investigations to verify data, determine regularity, and reduce the impact of experimental error
C5 Present the results of investigations in a variety of forums
C6 Contribute to the decisions regarding topics for investigation
C7 Use various creative means to communicate interpretations of scientific ideas, concepts, phenomena, and events
C8 Consider the scientific thinking and language of others
C9 Individually and collaboratively produce clearly written representations of investigative results
C10 Fulfill responsibilities as part of a research group
C11 Select and utilize resources by various criteria (e.g., efficiency, effectiveness, health, safety) that are appropriate to the investigations being conducted by groups
C12 Present persuasive argument based on the scientific aspects of controversial issues
C13 Collect, store, retrieve, and manipulate information with available t technologies alleges that may range from hand processes up through computer applications
C14 Investigate social issues with a scientific perspective (e.g., human rights, wellness, economics, futurism, environmental ethics)
C15 Keep journals of observations and inferences made over an extended period of time and reflecting upon the impact of these recorded ideas on their thinking and actions
C16 Examine the intellect, perspectives, and ethics of notable scientists
C17 Collect and analyze observations made over extended periods of time and compare these to scientific theories
C18 Create presentations of scientific understandings using diverse modes of expressions
C19 Conduct formal scientific debates in the classroom
C20 Wonder about the likelihood of events that may occur by chance or coincidence
C21 Plan and conduct field trips and experiences for small and large groups
C22 Analyze the historical context which leads to and has lead to scientific t theories

Subunit: Conditions for Learning Science (continued)
Competencies:

C23 Seek information on topics of personal scientific interest from a variety of sources
C24 Conduct learner-developed investigations independently and collaboratively over periods of week and months
C25 Listen attentively and critically to presentations of scientific information made by others
C26 Conduct analyses of propaganda related to scientific issues
C27 Perform investigations that require observations over varying periods of time
C28 Experience scientific concepts as interpreted by other cultures through multimedia and local and global specialists
C29 Access appropriate technology to perform complicated, time-consuming tasks
C30 Relate historical accounts of science to the cultural context in which they were written
C31 Work as a contributing member of a collaborative research group
C32 Examine the influences of social and political structures and realities that contribute to inquiry about scientific issues
C33 Use technology (e.g., desktop publishing, teleconferencing, networking) to communicate scientific ideas
C34 Explore and analyze a variety of perspectives on science (e.g., works by men and women of many racial, ethnic, and cultural groups)
C35 Lead groups of learners of various ages in designing, planning, and conducting science activities
C36 Respect the scientific thinking of others and self
C37 Recognize and contrast different epistemologies
C38 Develop possible courses of action in response to scientific issues of local and global concern
C39 Determine the validity of research conclusions in relation to the design, performance, and results
C40 Develop multimedia presentations of group and individual research projects and investigations appropriate for a variety of audiences and forums
C41 Produce interesting and scientifically correct stories and present them using various modes of expression
C42 Reflect on the ideas and content found in their own journal records
C43 Examine ambiguous results and formulate explanations
C44 Recognize and synthesize the contributions to scientific thought of individuals from many cultures

Subunit: Conditions for Learning Science (continued)
Competencies:

C45 Construct models and simulations of the component structures and functions of living and non-living entities
C46 Lead multi-age groups in the examination of and planned resolution for scientific issues
C47 Recognize and choose members of research teams based upon the merit of their ideas and skills
C48 Construct a portfolio of products, documentation, and self-evaluations of his/her own abilities, skills, and experiences
C49 Synthesize scientific information from a variety of sources
C50 Evaluate and prioritize scientific issues based upon risk-benefit analyses
C51 Refining scientific skills from a variety of experiences

Subunit: Applications for Science Learning

Competencies:

A1 Answer student-determined questions by designing databases and drawing inferences from the analyses of the information in these data bases

A2 Make personal behavior decisions by interpreting information that has a scientific basis

A3 Propose courses of action that will validate and demonstrate personal understandings of scientific principles

A4 Guide other learners in their understanding of the interactions of technologies and society at various periods in time

A5 Promote and carry out practices that contribute to a sustainable environment

A6 Study and propose improvements in public services and systems in their community

A7 Choose consumer materials utilizing personal and environmental risk and benefit information

A8 Make inferences and draw conclusions using databases, spreadsheets, and other technologies

A9 Do simple trouble-shooting on common electrical and mechanical systems, identifying and eliminating possible causes of malfunctions

A10 Construct devices that perform simple, repetitive actions

A11 Investigate the functionality of various geometric shapes in the natural world and the designed world (e.g., translations from spherical to plane representations cause distortions, triangular shapes contribute to rigidity and stability in structures, round shapes minimize boundary for a given capacity)

A12 Make decisions regarding personal and public health

A13 Evaluate the social and ecological risks and benefits resulting from the use of various consumer products

A14 Analyze the contributions of advances in technology through history to his/her everyday life

A15 Identify and reduce risks and threats to a sustainable environment

A16 Extend the limits of human capabilities using technological enhancements

A17 Use and recognize various propaganda techniques

A18 Solve unique problems using the results of systematic analyses

A19 Choose everyday consumer products that utilize recent innovation and pass appropriate performance criteria

A20 Refine personal career interests through investigations of the diversity of manufacturing, research, service, and invention processes

Subunit: Applications for Science Learning (continued)
Competencies:

A21 Predict and investigate the working of toys and tools while controlling and manipulating variables (e.g., friction, gravity, forces)
A22 Write, follow, modify, and extend instructions (e.g., equations, algorithms, formulas, flow diagrams, illustrations)
A23 Create products, make inferences, and draw conclusions using databases, spreadsheets, and other technologies
A24 Predict various scenarios and propose solutions to community issues using scientific information (e.g., actuarial tables, census data, topographic maps, incidence data, climatic data)
A25 Use scientific evidence to consider options and formulate positions about the health and safety of others and him/herself
A26 Search for, use, create, and store objects and information using various strategies and methods of organization and access
A27 Research and write environmental impact statements of his/her own design
A28 Compare school-based science perspectives with those gained through cutting-edge technological applications
A29 Design management plans for natural and human-altered environments (e.g., woodlots, patios, lots, lawns, farmlands, forests)
A30 Refine personal career interests
A31 Promote public awareness of the interaction of technology with social i issues
A32 Advocate and propose courses of action for local and global scientific issues using global networks
A33 Use appropriate technologies to prepare and present the findings of investigations incorporating tables, graphs, diagrams, and text
A34 Make informed consumer choices by evaluating and prioritizing information, evidence, and strategies
A35 Develop an informed point-of-view that allows for validation or refutation of the scientific statements and claims of advocated before pursuing courses of action (e.g., contributing support, signing petitions, casting votes)
A36 Differentiate between observations and inferences in the exploration of evidence related to personal, scientific, and community issues
A37 Develop and write environmental impact and safety and hygiene management plans
A38 Use technology to collect, analyze, and communicate information (e.g., electronic networks, desktop publishing, remote sensing, graphing calculators, satellite telemetry, and others)
A39 Design, construct, and market inventions

Unit: Technology Literacy

NOTE: Over 500 Ohio business, industry, and labor representatives examined, altered, and then verified the content for this unit during the TCP Process. The original content was extracted from the Report of the Task Force on Technology Competence—Learner Goals for All Minnesotans, published by the Minnesota State Council on Vocational Technical Education. The Technology Literacy unit forms a critical link between all teachers and stresses the importance of technological impact on teaching and learning. [See "The TCP Process" for more information.]

Competencies:

T1 Demonstrate a systems view of technology based on the interdependence of social, political, economic, and ecological systems
T2 Assess the career, family, and personal development implications of technological change
T3 Demonstrate continuous learning via technology
T4 Demonstrate global appreciation for technology's potential effects on cultures, geographic areas, and the environment
T5 Apply historical perspective on technology to the development and use of new technologies
T6 Apply diverse technologies to store, access, process, create, and communicate information needed to solve problems
T7 Apply legal principles and ethical conduct to the use of technology
T8 Demonstrate competency in mathematics, science, social sciences, communication, and computer skills through the analysis, design, and evaluation of technological systems
T9 Analyze the potential of alternative technological systems to solve problems and/or to extend human capabilities
T10 Use a variety of tools, materials, and equipment in solving problems and extending human capabilities
T11 Assess risks and benefits of technological developments from an ecological, economic, social, and political perspective
T12 Value human diversity as part of a team in suggesting, designing, and testing solutions to technological problems

Unit: Employability Skills

Competency: Develop a career plan

Competency Builders:

Identify current interests and aptitudes
Identify common barriers to employment
Describe strategies to overcome employment barriers
Locate resources for finding employment
Research job trends
Identify career options
Identify advantages and disadvantages of career options (in addition to other than monetary)
Identify job requirements
Investigate education/training opportunities
Evaluate personal strengths and weaknesses

Competency: **Prepare for employment**

Competency Builders:

Identify traditional and non-traditional employment sources
Identify present and future employment opportunities (by geographic location)
Research job opportunities, including non-traditional careers
Compare salary ranges and benefit packages
Compile occupational profile
Identify rights and responsibilities of equal employment opportunity laws
Design resume and cover letter
Target resume
Secure references
Investigate generic and specific employment tests (e.g., civil service exam; drug screening)
Use follow-up techniques to enhance employment potential
Demonstrate legible written communication skills using correct grammar, spelling, punctuation, and concise wording
Describe methods for handling illegal questions on job application forms and during interviews
Write letter of application
Research prospective employer and services performed
Explain critical importance of personal appearance, hygiene, and demeanor
Interpret job description
Demonstrate appropriate interview question and answer techniques
Demonstrate methods for handling difficult interview questions
Evaluate job offers
Write letter of acceptance
Write letter of declination
Demonstrate good listening skills
Ask for the job tactfully
Participate in extracurricular activities (e.g., student government, community projects,)

Competency: **Evaluate the importance of self-esteem as an employability skill**

Competency Builders:

Identify factors that affect self-esteem
Compare effects of low self-esteem and high self-esteem
Identify strategies to promote positive self-esteem

Competency: **Demonstrate job retention skills**

Competency Builders:

Identify employer expectations regarding job performance, work habits, attitudes, personal appearance, and hygiene
Exhibit appropriate work habits and attitude
Demonstrate ability to set priorities
Identify behaviors to establish successful working relationships
Identify alternatives for dealing with harassment, bias, and discrimination based on race, color, national origin, sex, religion, handicap, or age
Identify opportunities for advancement
List reasons for termination
List consequences of being absent frequently from job
List consequences of frequently arriving late for work
Demonstrate interpersonal relations skills (i.e., verbal and written)
Demonstrate negotiation skills
Demonstrate teamwork
Follow chain-of-command
Exhibit appropriate job dedication

Competency: **Demonstrate knowledge of work ethic**

Competency Builders:

Define work ethic
Identify factors that influence work ethic
Differentiate law and ethics
Describe how personal values are reflected in work ethic
Describe how interactions in the workplace affect personal work ethic
Describe how life changes affect personal work ethic

Competency: Exhibit appropriate work ethic

Competency Builders:

Use time-management techniques
Avoid personal activity during work hours
Attend work as scheduled
Adhere to company and/or governmental policies, procedures, rules, and regulations
Exercise confidentiality
Demonstrate appropriate human relations skills
Adhere to rules of conduct
Accept constructive criticism
Offer constructive criticism
Take pride in work
Resolve conflict
Manage stress
Avoid sexual connotations and harassment
Adjust to changes in the workplace
Demonstrate punctuality
Assume responsibility for personal decisions and actions
Take responsibility for assignments
Follow chain-of-command

Competency: Apply decision-making techniques

Competency Builders:

Identify decision to be made
Identify ownership of decision to be made
Identify possible alternatives and their consequences
Make decisions based on facts, legality, ethics, goals, and/or culture
Apply time factor(s)
Present decision to be implemented
Evaluate decision made
Take responsibility for decision

Competency: Apply problem-solving techniques

Competency Builders:

Identify problem
Select appropriate problem solving tools/techniques
Identify root problem cause(s)
Track root problem cause(s)
Identify possible solutions and their consequences (e.g., long term, short term, crisis)
Use resources to explore possible solutions to problem
Contrast advantages and disadvantages of each solution
Identify appropriate action
Evaluate results
Identify post-preventive action

Competency: Exhibit characteristics for job advancement

Competency Builders:

Display positive attitude
Demonstrate knowledge of position
Perform quality work
Adapt to changing situations and technology
Demonstrate capability/responsibility for different positions
Identify characteristics of effective leaders
Identify opportunities for leadership in work place/community
Demonstrate initiative to affect change in workplace
Participate in continuing education/training program
Responds appropriately to criticism from employer, supervisor, or other employees
Exhibit awareness of corporate culture
Prepare for job setbacks
Exhibit continual growth based on performance evaluation
Set realistic goals

Unit: Professionalism

Competency: Project professional image

Competency Builders:

Define professionalism
Exhibit professional appearance
Exhibit professional manners
Project professional attitude
Identify individuals' vital role in organization
Exhibit proper etiquette in professionally-related situations

Competency: Achieve individual and professional goals

Competency Builders:

Set flexible, realistic, and measurable goals
Identify potential barriers to achieving goals
Identify strategies for addressing barriers to goal achievement
Breakdown long-term goals into short-term goals
Prioritize goals
Commit to goals
Adjust goals
Obtain support for goals
Reward goal achievement

Competency: Manage personal finances

Competency Builders:

Explain need for personal management records
Balance checkbook
Identify tax obligations
Analyze how credit affects financial security
Compare types and methods of investments
Compare types and methods of borrowing
Compare types and methods of insurance
Compare types of retirement options/plans
Identify discriminatory vs. non-discriminatory expenditures

Competency: Support community well-being

Competency Builders:

Identify environmental, educational, and social issues
Participate in social and/or community activities

Competency: Achieve organizational goals

Competency Builders:

Evaluate personal goals in relation to organizational goals
Monitor progress by evaluating feedback
List responsibilities in relation to organization goals
Accomplish assigned tasks
Exercise responsibility in relation to organizational goals
Set appropriate personal performance standards
Communicate goals with supervisor and peers
Demonstrate knowledge of products and services
Promote organizational image and mission

Competency: Demonstrate positive relations in the workplace

Competency Builders:

Identify personality types of self and other
Identify various management styles
Support employer expectations
Support employer decisions
Accept constructive criticism
Give constructive feedback
Adapt to changes in workplace
List factors to consider before resigning
Write letter of resignation

Competency: Manage stressful situations

Competency Builders:

Accept stress as part of daily life
Identify personal and professional factors contributing to stress
Describe physical and emotional responses to stress
Evaluate positive and negative effects of stress on productivity
Identify strategies for reducing stress
Implement strategies to manage stress
Create strategies for developing and maintaining support systems

Competency: Analyze effects of family on work and work on family

Competency Builders:

Identify how family values, goals, and priorities are reflected in work place
Identify responsibilities and rewards associated with paid and non-paid work
Identify responsibilities and rewards associated with families
Explain how family responsibilities can conflict with work
Explain how work can conflict with family responsibilities
Explain how work-related stress can affect families
Explain how family-related stress can affect work
Identify family support systems and resources
Identify work-related support systems and resources
Communicate with family regarding work

Competency: Apply lifelong learning skills

Competency Builders:

Define lifelong learning
Identify factors that cause need for lifelong learning
Analyze effects of change
Identify reasons why goals change
Describe importance of flexibility and adaptability
Evaluate need for continuing education/training

Competency: **Manage professional development**

Competency Builders:

Identify career opportunities
Modify career plan
Participate in continuing education/training opportunities
Document continuing education/training
Read profession-related manuals, technical journals, and periodicals
Attend meetings, workshops, seminars, conferences, and demonstrations
Participate in professional organizations
Build personal/professional mentor relationship
Build personal/professional support system
Build professional network
Strengthen communication skills
Strengthen leadership skills
Strengthen management skills

Unit: Teamwork

Competency: Demonstrate knowledge of teamwork

Competency Builders:

Define empowerment
Differentiate work groups and teams
Identify conditions essential to teamwork (e.g., brainstorming)
Explain influence of culture (e.g., corporate, community) on teamwork
Identify appropriate situations for using teams
Define team structures (e.g., cross functional, quality improvement, task force, quality circles)
Identify team building concepts
Describe characteristics and dynamics of teams
Identify characteristics of effective team leaders and members
Identify responsibilities of a valuable team member
Identify methods of involving each member of a team
Explain how individuals from various backgrounds contribute to work-related situations (e.g., technical training, cultural heritage)
Explain the purpose of facilitators
Define consensus
Define reward/recognition system

Competency: Demonstrate teamwork

Competency Builders:

Identify purpose of team and intended goal (include time frames)
Structure team around purpose
Define responsibilities of team members
Contribute to efficiency and success of team
Work toward individual and team milestones
Analyze results of team project
Facilitate a team meeting
Assist team member(s) with problem
Monitor time frame
Stress continuous improvement
Accept failure as part of learning

Competency: Use teamwork to solve problems

Competency Builders:

Identify appropriate situations for using teams
Use problem-solving process in a team setting
Identify quality management processes/techniques
Identify quality assurance processes/techniques
Prepare presentation

Competency: Conduct team meetings

Competency Builders:

Plan agenda
Schedule meeting and location
Invite appropriate personnel
Solicit outside speakers as needed
Assign someone to take minutes
Facilitate introductions
Invite questions and comments and group participation
Focus team on agenda items
Assign appropriate action, time frame and accountability to tasks
Monitor time
Close meeting on time
Publish minutes in timely manner
Set ground rules
Avoid placing individual agendas above the group's agenda

Unit: Quality Assurance

Competency: **Demonstrate knowledge of quality assurance**

Competency Builders:

Explain the historical evolution of quality assurance (e.g., Deming, ISO 9000)
Explain changes brought about by quality leaders in the world
Explain the ISO 9000 process
Define quality terms
Define quality functions
Identify features of quality planning
Describe control devices used in functional areas (e.g., SPC, equipment)
Explain the relationship among organizational structures, policies, procedures, and quality assurance
Explain importance of internal and external customers
Identify internal and external customers
Describe successful efforts by industry to improve quality and/or reduce costs
Differentiate prevention and detection
Differentiate variable and attribute data
Identify types of coontrol charts
Explain how statistical techniques are tools used to control quality (e.g., SPC, DOE, CR)

Competency: Demonstrate knowledge of quality cost implications

Competency Builders:

Identify cost/quality objectives
Classify costs (i.e., direct and indirect, fixed and variable, methods and standards)
Classify quality costs (i.e., prevention, evaluation, pre-delivery failure, post-delivery failure)
Define produce liability
Interpret quality cost reports
Explain consumerism and liability prevention
Define safety terms of product
Identify safety responsibility within organization
Define contracts and torts
Differentiate express and implied warranty
Differentiate warranty and product liability
Explain how warranties are part of contract law
List questions that would need answering in liability claim

Competency: Demonstrate knowledge of engineering a quality product

Competency Builders:

Associate customer satisfaction with product characteristics (e.g., usefulness, price, operation, life, reliability, safety, cost of operation)
Define manufacturability
Identify steps in product design (e.g., brainstorming, thumbnail sketches, rendering)
Define reliability factors (e.g., cost, human, producibility)
Identify ways reliability is achieved (e.g., maintainability, good design, design simplification, design redundancy)
Explain the relationship of maintainability to reliability
Define failure
Explain the role of testing and reliability
Define value engineering
Define quality objectives
Identify cost components as they relate to quality objectives
Classify quality costs (i.e. preventive, evaluation, pre-delivery failures, post delivery failures)
Describe predictive maintenance

Competency: **Explain importance of interdepartmental relationships to quality assurance**

Competency Builders:

Explain need for everyone's commitment in assuring quality
Explain phrase "Everyone is a customer/supplier"
Define quality improvement team models
Explain the importance of top management's support of quality
Explain project selection
Explain project implementation
Explain project evaluation
Explain continuing improvement
Describe future trend of experiment design
Describe future trend of predictive maintenance

Competency: **Manipulate quality cost data**

Competency Builders:

Develop quality cost data
Translate cost reports
Graph quality cost data (e.g., pareto)

Competency: **Manipulate cost control data**

Competency Builders:

Develop cost control data
Analyze cost control reports
Provide cost control data
Provide advice on "Make or Buy" decisions (including economical lot size decisions)

Competency: Demonstrate knowledge of basic statistics

Competency Builders:

Describe data collection methods
Collect data
Organize data by flow chart
Interpret data by cause and effect diagrams
Define nominal, ordinal, interval, and ratio data
Define mean, median, and mode
Explain significance of standard deviation
Explain normal distribution

Competency: Demonstrate knowledge of scattergrams

Competency Builders:

Construct scattergram
Interpret for positive, negative, or no correlation between X and Y variables
Test for significance between one and five percent
Explain regression analysis

Competency: Demonstrate knowledge of probability theory

Competency Builders:

Define classical probability
Define empirical probability
Calculate probability for outcomes

Competency: Demonstrate knowledge of precontrol

Competency Builders:

Explain uses of precontrol
Calculate precontrol limits
Explain significance of the limits
Plot values on a precontrol chart
Explain "out-of-control" situation
Make decisions on green, yellow and red conditions

Competency: Demonstrate knowledge of process capability

Competency Builders:

Use X, R, USL, and LSL to determine process capability (upper and lower specification limits)
Calculate estimated process standard deviation
Plot right hand and left hand tail of process variation
Compute Z value for percent of probable defect for process
Calculate C_{PK} values that describe process capability
Describe skewed distributions
List probable causes of skewed distribution

Competency: Use quality control charts

Competency Builders:

Identify operational definitions for attribute criteria
Interpret histogram
Interpret scattergrams
Interpret NP chart
Interpret P chart
Interpret flowchart
Interpret cause-and-effect diagram
Construct P (percentage defective) chart for attributes
Plot control limits of P chart and data points
Check chart for out-of-control conditions
Construct an NP (number defective) chart with control limits and data
Construct C (count of defects) and U (number of defects per unit) charts
Check data on C and U charts
Construct flowchart
Construct cause-and-effect chart

Competency: Interpret $\overline{X}$ and R charts

Competency Builders:

Plot percentages for normal distribution
Test distribution for normality
Explain difference between common cause and special cause
Define an "in-control" process
Explain significance of an out-of-control point on $\overline{X}$ or R chart
Identify patterns and trends on control chart
Identify run up and run down
Test for middle third on control chart
Explain significance of middle third on control chart
Explain Rule of Sevens

Competency: Construct $\overline{X}$ and R charts

Competency Builders:

Arrange data into statistical sub-groups
Explain importance of random sampling
Compute $\overline{X}$ (i.e., average of values) and R (i.e., range of values in subgroup) within sample
Plot in $\overline{X}$ and R on chart
Construct control chart with $\overline{\overline{X}}$ (grand average) and R (average range) calculated
Calculate upper and lower control limits for $\overline{X}$-chart
Calculate upper and lower control limits for R-chart

Competency: Conduct process improvement studies

Competency Builders:

Analyze production methods and processes applying statistical process improvement techniques (e.g., SPC, C_{PK})
Identify appropriate statistical techniques for study (e.g., T-tests, F-test, capability, DOEX)
Identify major steps in conducting a study
Define "report" for a study (e.g., goal, objective, study conduct, results, conclusions, discussions)
Integrate results into the total system

Competency: Demonstrate knowledge of JIT

Competency Builders:

Define just-in-time concept (JIT)
Describe various production methodologies (e.g., standard cycle times, routings, standard quantities, multiple-machine tending)
Describe types of inventory control (e.g., Kanban)
Describe importance of flexibility
Differentiate product layout, process layout, fixed position layout, and cellular layout
Differentiate straight-line, U-shaped, S-shaped, convoluted and comb patterns
Describe advantages/disadvantages of layout and patterns
Explain importance of product protection, identification and storage
List methods of identifying products (e.g., labels, bar codes, radio frequency systems and magnetic strip systems)
Describe manual methods of storage and retrieval
Describe automated storage and retrieval systems (ASRS)
Describe automated guided vehicle moving systems (AGVS)

Competency: Apply JIT

Comptency Builders:

Maintain system for physical handling and movement of material in-process and in-storage
Monitor system of physical handling and movement of material in-process and in-storage
Maintain system for physical handling and movement of finished products
Monitor system of physical handling and movement of finished products
Write requests for deviation from specifications
Implement quality control and inspection standards and procedures
Write engineering change notices and rejection reports
Monitor reports of discrepancy or rejects during production process
Conduct quality tests under different environmental conditions

Competency: Demonstrate knowledge of inspection

Competency Builders:

Explain purpose of inspection
Describe scope of inspection
Explain purpose of incoming, ongoing, and final inspections
Explain early detection inspection
Explain how statistical process control (SPC) aids inspection
Define types of nonconformance
Define degrees of nonconformance
Define corrective action
Describe when to 100% inspect
Describe when to sample inspect
Describe methods of testing for material properties (e.g., harness, strength, chemical makeup, flaws, errors in tooling or setup)
Define rework, salvage, and scrap
Describe ethical decisions an inspector may make
Identify purposes of computer-automated inspection
Explain advantages and limitations of automated inspection
Explain disposition of non-conforming material
Explain basic foolproofing concept to build inspection into process (i.e., poka-yoke)
Use checksheets to organize and record inspection results

Competency: Inspect machinery, materials, and products

Competency Builders:

Identify critical material characteristics from specification(s) or drawing(s)
Perform capability studies for machinery and materials acceptance
Identify appropriate acceptance sampling plan
Conduct incoming materials inspection using sampling plan criteria
Identify critical in-process characteristics from specification(s) or drawing(s)
Demonstrate basic metrology skills
Conduct in-process inspection
Identify appropriate inspection reports and follow-up
Gauge R and R (reproducibility and repeatability)
Apply geometric tolerancing
Explain C = O (zero) acceptance plan
Interpret instructions in a control plan

Competency: **Demonstrate knowledge of nondestructive testing**

Competency Builders:

Describe purpose of nondestructive testing
Identify anomalies
Define defects and discontinuities
Identify factors contributing to defects and discontinuities
Describe ultrasonic testing
Describe advantages and limitations of ultrasonic testing
Describe industrial radiography
Compare use of wet and dry particles in magnetic particle inspection
Explain advantages and limitations of penetrant inspection
Describe microwave testing
Describe holographic inspection
Explain choice of most suitable nondestructive test method
Describe eddy-current testing

Unit: Technical Recording and Reporting

Competency: Demonstrate proficiency in technical recording

Competency Builders:

Describe various documentation procedures
Interpret specifications or drawings
Observe process
Ask open-ended questions
Record process (e.g., flowchart, step-by-step)
Identify parameters
Record accurate, truthful data
Maintain test logs
Compile cumulative reference notebook/record
Measure appropriate parameters
Draft preventive maintenance and calibration procedures

Competency: Demonstrate proficiency in technical reporting

Competency Builders:

Use data books and cross reference/technical manuals
Compose technical memoranda
Identify type of report or format needed
Use appropriate format
Compile relevant data
Design charts and graphs
Analyze data
Draw conclusions
Explain analytical methods used
Outline reports
Write reports
Present reports

Unit: Computer Literacy

Competency: Describe personal computer operations

Competency Builders:

Explain how data is stored in main computer memory
Explain how computer system executes program instruction
Explain computer storage capacity
Explain how data is represented
Describe data storage techniques
Identify types of memory

Competency: Explain information processing cycle

Competency Builders:

Define operating systems (e.g., DOS, OS/2, UNIX, MAC)
Describe computer languages and their use
Describe computer languages and their use
Describe computer languages and their use
Describe difference between data files and program files
Explain PC layout
Explain PC network layout
Explain mini/mainframe network layout
Differentiate hardware and software
Differentiate open from proprietary architecture

Competency: Operate computer hardware

Competency Builders:

Practice proper media handling techniques (e.g., magnetic fields, dust, liquids)
Identify hardware and its use
Use hardware (e.g., mouse, diskettes, drive, modems, touch screen, printers, digitizers, scanners, cables, protection devices)
Keyboard efficiently
Demonstrate basic care of hardware
Explain need for and application of security levels/procedures
Perform basic hardware troubleshooting
Explain hardware addressing techniques

Competency: Use software

Competency Builders:

Define software types and functions
Describe basic disk operations and care
Perform functions necessary to operate software
List advantages and disadvantages of integrated and dedicated software
Operate system software
Operate diagnostic software
Demonstrate basic proficiency in spreadsheet use
Demonstrate basic proficiency in word processing
Demonstrate basic proficiency in database use
Demonstrate basic proficiency in network use
Demonstrate basic proficiency of utility (e.g., WINDOWS, GUI)
Demonstrate basic proficiency in report writing
Demonstrate system commands
Differentiate ethical use/misuse of software
Describe bulletin boards/electronic mail
Apply security levels/procedures while handling sensitive data
Explain data compression techniques
Explain use and deletion of passwords

Unit: Workplace Safety

Competency: Apply general safety precautions

Competency Builders:

Identify local, state, and federal rules and regulations
Identify personal protective wear and equipment
Identify visual controls (e.g., monitors, read outs)
Identify auditory controls
Identify common sense housekeeping
Interpret hazardous materials notices on containers
Use personal protective wear and equipment
Apply workplace safety rules and procedures
Apply personal safety rules and procedures
Apply workplace organization (e.g., housekeeping)
Apply applicable electrical, mechanical, steam, hydraulic and (e.g., pneumatic safety rules and procedures)
Apply fire safety rules and procedures
Apply hazardous wastes rules and procedures
Apply first aid
Locate (MSDS)
Perform lockout and tagout
Recycle scrap metal, chips, shavings, coolants, solvents, trash, and waste materials
Apply common sense housekeeping
Use preventive maintenance checklists

Competency: **Demonstrate knowledge of safety and workplace hazards**

Competency Builders:

Describe corrective procedures for unsafe conditions
Identify types and potential level of workplace hazards (e.g., physical hazards, fire, chemicals, noise, ionizing radiation, ultraviolet, temperature extremes, ergonomics, biological hazards)
Identify safety materials/equipment (e.g., absorbant socks, oil dry)
Interpret Material Safety Data Sheets (MSDS)
Explain purpose(s) of OSHA and NIOSH
Explain purpose(s) of NEC and NFPA
Identify purpose of emergency evacuation routes, master switch and lockout locations, and safety color coding systems
Identify roles of industrial hygienists, safety professionals, occupational physicians, and occupational nurses
Describe methods of evaluating potential hazards (e.g., visual analysis)
Describe methods of correcting potential hazards
Describe various types of toxicity (e.g., chronic, immediate)
Identify need for reporting accidents
Explain precautions required when using toxic or flammable materials
Define confined space and related requirements
Explain how international directives relate to safety

Competency: **Explain purpose of industrial pollution control systems**

Competency Builders:

Describe types of air, water, solid waste, and noise pollution
Explain purpose of air pollution control systems
Explain purpose of water pollution control systems
Explain purpose of solid waste pollution control systems
Explain purpose of noise pollution control systems
Explain basic philosophy of "right to know" legislation
Explain purpose(s) of EPA
Identify "costs" of industrial pollution control (i.e., dollars vs. impact to environment)
Describe ethics of environmental issues

Competency: **Demonstrate knowledge of ergonomics**

Competency Builders:

Define ergonomics
Define risk factor
Define maximum permissible limit (MPL) and action limit (AL) for lifting
Define cumulative trauma disorder (CTD)
Identify susceptibility factors for CTD
Minimize extreme joint movement
Minimize use of excessive muscle force
Minimize repetitive tasks
Minimize mechanical stresses (e.g., sharp edges, heat, cold, hard surfaces, weights, vibration)
Minimize awkward body positions
Explain use of rest pauses
Explain need for mats and footrest for standing jobs
Explain need for appropriate working heights of chairs, stools, workbenches, equipment
Explain need for adequate lighting
Explain use of anthropometric (i.e., centering one's view of everything around man) design

Unit: Troubleshooting and Repair

Competency: Demonstrate troubleshooting skills

Competency Builders:

Explain role of preventive maintenance
Differentiate normal and abnormal operations
Explain troubleshooting procedures
Explain logical actions taken to troubleshoot
Use proper troubleshooting aids
Demonstrate knowledge of safety rules for troubleshooting and repair procedures
Maintain troubleshooting and repair records
Interpret prints (e.g., PID, loopsheets)
Use manufacturer's manuals, schematics, and troubleshooting charts
Isolate faults, shorts, and open circuits

Competency: Apply troubleshooting techniques to DC circuits

Competency Builders:

Identify noise problems
Isolate faults in series, parallel and series parallel
Isolate faults in bridge circuits
Isolate faults in DC power supplies
Perform polarity check
Isolate faults to DC drive system
Isolate faults in voltage divider circuits
Repair faults

Competency: Apply troubleshooting techniques to AC circuits

Competency Builders:

Isolate faults in capacitive circuits
Isolate faults in inductive circuits
Isolate faults in AC circuits utilizing transformers (e.g., step up and step down)
Isolate faults in differentiator and integrator circuits
Isolate faults in RC, RL, and RLC circuits
Isolate faults in frequency selective filter circuits
Isolate faults to AC frequency drive systems
Repair faults

Competency: Apply troubleshooting techniques in discrete solid-state devices

Competency Builders:

Isolate faults in diode circuits
Isolate faults in thyristor circuitry (e.g., SCR, TRIAC, DIAC)
Isolate faults in transistor circuits
Isolate faults in operational amplifier circuits
Isolate faults in single-stage amplifiers
Isolate faults in open circuits
Repair faults

Competency: Apply troubleshooting techniques to analog circuits

Competency Builders:

Isolate faults in single and multistage amplifiers
Isolate faults in audio power amplifiers
Isolate faults in regulated and switching power supply circuits
Isolate faults in active filter circuits
Isolate faults in oscillator circuits
Isolate faults in operational amplifier circuits
Isolate faults in power supplies (loaded and unloaded) and filters
Repair faults

Competency: **Apply troubleshooting techniques to digital circuits**

Competency Builders:

Identify noise problems
Isolate faults in multiplexer and demultiplexer circuits
Isolate faults in digital display circuits
Isolate faults in logic gates
Isolate faults in flip-flops
Isolate faults in registers and counters
Isolate faults in clock and timing circuits
Isolate faults in arithmetic-log circuits
Isolate faults in encoders and decoders
Isolate faults in digital-display devices
Repair faults

Competency: **Apply troubleshooting techniques to a microcomputer system**

Competency Builders:

Isolate faults to systems boards
Isolate faults to memory circuits
Isolate faults to data storage devices
Isolate faults in power supplies
Troubleshoot I/O ports
Isolate faults in I/O interface circuitry
Use diagnostic software
Repair faults

Competency: **Apply troubleshooting techniques to manufacturing systems**

Competency Builders:

Identify individual process blocks of assembly line or process
Identify process block interfaces
Demonstrate steps required for efficient systems troubleshooting
Isolate system faults to process block
Isolate block faults using schematics
Isolate block faults using programmable controller indicators
Isolate block faults using volt meter
Repair block faults by replacing fault component or wiring

Unit: Drafting Technology

Competency: Apply basic drafting skills

Competency Builders:

Use drafting equipment, measuring scales, drawing media, drafting instruments and consumable materials, blueprint machine
Identify line styles, weights (alphabet of lines)
Select proper drawing scale, introduction to different types
Prepare title blocks and other drafting formats
Apply freehand and other lettering techniques
Prepare multi-view drawings
Prepare multi-view sketches
Prepare orthographic views
Prepare change control block
Describe change control block/revision block
Measure angles
Draw horizontal, vertical, angular, parallel, and perpendicular lines
Transfer an angle
Construct tangent lines (to arcs) and tangent arcs (to arcs)
Bisect angles and arcs
Bisect lines
Divide lines
Construct three-point circle
Construct regular hexagon, pentagon, and octagon
Reproduce a drawing
Prepare single-view drawings
Prepare dimension drawings
Interpret notes and dimensions to determine part
Draw arcs, circles, and conics
Transfer measurements

Competency: Apply intermediate drafting skills

Competency Builders:

Describe types of blueprints and their applications
Apply isometric, oblique and perspective sketching techniques
Prepare isometric, oblique and perspective sketches
Prepare sectional views
Prepare auxiliary views
Identify ANSI symbols
Prepare views of drilled and tapped holes, counterbores, countersinks
Apply systems drafting techniques
Identify a bill of materials
Dimension drawings using ANSIy14.5 standards
Describe purpose of auxiliary and sectional views

Competency: Apply advanced drafting skills

Competency Builders:

Interpret reports and specifications
Prepare pictorial drawings
Prepare schematics
Draw conics
Interpret basic pneumatic/hydraulic standard and symbols
Interpret various drawings (e.g., welding, casting, stamping, forging, civil, maps, pattern shop)

Competency: Interpret basic prints

Competency Builders:

Visualize object from drawing
Interpret orthographic projections
Interpret isometric views
Interpret sectional views
Interpret detail and assembly drawings
Interpret dimensions
Interpret tolerances

Competency: Interpret intermediate prints

Competency Builders:

Interpret screw thread specifications
Identify structural steel shapes
Interpret special symbols
Interpret electrical, pneumatic/hydraulic drawings
Interpret schematics

Competency: Interpret advanced prints

Competency Builders:

Interpret GD&T characteristic symbols
Interpret GD&T supplementary symbols

Competency: **Demonstrate knowledge of basic geometric dimensioning and tolerancing**

Competency Builders:

Identify geometric characteristics and symbols (i.e., flatness, straightness, roundness, cylindricity, profile of line, profile of surface, perpendicularly, angularity, parallelism, circular, runout, total indicated runout, position, concentricity, and symmetry)
Define maximum material condition
Define least material condition
Define regardless of feature size condition
Describe feature control blocks
Describe datum surfaces and targets
Define flatness (pitch)
Define straightness (yaw)
Define roundness
Define cylindrically
Define profile of line
Define profile of surface
Define perpendicularity
Define angularity
Define parallelism
Define circular runout
Define total runout
Define true position concept to determine tolerance for location of holes in mating parts

Competency: **Convert dimensions and tolerances**

Competency Builders:

Convert dimensions and tolerances from English units to metric units
Convert dimensions and tolerances from metric units to English units

Competency: Apply revision control process

Competency Builders:

Apply drawing balloons
Apply documentation (including project filing, back-up material, tracking process)
Apply change control block
Apply revision levels

Competency: Demonstrate dimensioning techniques

Competency Builders:

Construct arrowheads using various styles/disciplines
Apply symbols for surface and texture control
Add labels/notes to drawing
Interpret decimal tolerance dimensions
Dimension arcs
Dimension angles
Dimension curves
Dimension rounded-end shapes
Dimension spherical objects
Dimension cylindrical objects
Dimension cones, pyramids, and prisms
Dimension features on circular center line
Dimension theoretical point of intersection
Dimension object using rectangular coordinate system
Dimension object using polar coordinate system
Dimension object using tabular coordinate system
Dimension object using ordinate dimensioning system

Competency: Apply geometric dimensioning and tolerancing

Competency Builders:

Interpret decimal tolerance dimensions
Calculate clearance fit tolerances of mating parts
Dimension clearance fit tolerances of mating parts
Calculate interference fit tolerances of mating parts
Dimension interference fit tolerances of mating parts
Calculate tolerances to mating parts using standard fit tables
Assign tolerances to mating parts using standard fit tables
Apply positional and form tolerancing symbols
Apply symbols for true position
Apply symbols for maximum material control and regardless of feature size
Calculate effects of dimensional stack-up
Calculate transitional fit tolerances
Dimension transitional fit tolerances

Competency: Perform basic physical layouts

Competency Builders:

Use inside diameter (ID), outside diameter (OD), and hermaphrodite calipers
Layout with combination square
Layout with scriber, divider and trammel
Use surface plate
Use surface gage
Use layout fluid
Use V-blocks
Use clamps
Use angle plate
Use parallels
Use punches
Use transfer method tools
Use layout hammer
Use machinist's square
Use universal bevel protractor
Use machinist's scale

Competency: Prepare mechanical drawings

Competency Builders:

Interpret basic mechanical standards and symbols
Prepare assembly drawings
Prepare welding drawings
Prepare bearing drawings
Prepare casting drawings
Prepare forging drawings
Prepare tool drawings
Prepare molding diagrams
Prepare drawings with special processed holes
Prepare stamping drawings
Prepare numerical control drawings/instructions
Prepare installation drawings
Prepare purchase part drawings
Prepare approval drawings

Competency: Prepare advanced mechanical drawings

Competency Builders:

Resolve problems by descriptive geometry and revolutions
Use precision dimensioning to include geometric characters
Use precision measuring instruments (e.g., calipers)
Prepare fastener drawings
Prepare cam drawings
Prepare gear drawings
Prepare spring drawings
Prepare pulley and chain drive drawings

Unit: CADD Fundamentals

Competency: **Demonstrate basic use of computer operating system**

Competency Builders:

Create ASCII text files with a text editor
Explain rules for naming files and directories
Manage files
Create directories
Remove directories
Change directories
Copy files
Rename files
Erase files
Format diskettes
Label diskettes
Explain the syntax of operating system commands
Use wildcards in operating system commands

Competency: **Operate a CADD system**

Competency Builders:

Execute CADD system
Use keyboard input
Use screen and tablet menus
Use other input devices (e.g., scanner, digitizer)
Create scaled plots
Operate a pen plotter
Operate a printer-plotter (i.e., laser plotter)
Access on-line help for commands
Use file conversion
Use data transfer

Competency: Select entities for action

Competency Builders:

Add or remove entities separately
Add or remove entities using a window
Add or remove entities with a crossing-box
Select entities using a fence
Select entities by other methods (e.g., last, previous, type, all, etc.)

Competency: Create 2-D orthographic drawings

Competency Builders:

Create primitive drawing entities
Draw utilizing absolute Cartesian coordinates
Draw utilizing relative Cartesian coordinates
Draw utilizing polar coordinates
Draw using construction aides (e.g., snaps, grid, snap, etc.)
Change drawing attributes
Edit drawing entity properties (e.g., color, layer, thickness, linetype)
Construct drawing entities (e.g., offset, timer, extend, break, mirror, etc.)
Edit drawing entities (e.g., offset, trim, extend, break, mirror, etc.)
Set system variables (e.g., units, scale)
Use system variables
Create layers
Name layers
Manipulate layers
Save files
Create back-ups
Create hatches, patterns, symbols
Recall drawing templates/blocks

Competency: Annotate orthographic drawings

Competency Builders:

Create text styles
Edit text styles
Select text styles
Apply notes

Competency: Dimension orthographic drawings

Competency Builders:

Create dimensions
Edit text
Control dimension variables/models

Competency: Control display

Competency Builders:

Apply view control while drawing (e.g., zoom and pan)
Control view resolution (e.g., viewers)
Save views
Display views

Competency: Extract entity and drawing information

Competency Builders:

Measure distances
Measure areas
Identify locations
List entity characteristics (e.g., length, size, location, properties, etc.)

Unit: Equipment Maintenance

Competency: Perform housekeeping

Competency Builders:

Dispose of scrap metal chips, shavings, trash and waste
Clean work area
Store hand tools, cutters, fixtures, jigs and attachments
Store grinding wheels
Follow tool crib procedures
Inspect machine guards
Replace or adjust machine guards
Report problems to supervisor

Competency: Perform recordkeeping

Competency Builders:

Explain reasons for keeping maintenance records
Explain reasons for keeping cost records
Complete work order
Complete internal requisition
Complete external requisition
Complete time cards
Complete job status reports
Complete equipment failure reports
Record preventive maintenance activities
Record repair activities
Read job orders and process sheets
Locate tooling and set up information
File reports
Prepare new/replacement equipment recommendations

Competency: **Inspect machine systems**

Competency Builders:

Explain planned maintenance
Explain predictive maintenance measures
Explain preventive maintenance measures (e.g., lubrication)
Log machine histories
Explain machine system(s) calibration
Inspect linkages and lever mechanisms
Inspect drive couplings
Inspect clutches
Inspect roller ball bearings
Inspect safety systems
Analyze system failure
Make minor adjustments/repairs
Coordinate maintenance services

Competency: **Perform machine maintenance**

Competency Builders:

Use operator's and manufacturer's manuals
Operate individual machines
Diagnose malfunctions
Apply lockout/tagout procedure
Disassemble defective section
Clean equipment
Lubricate equipment
Check equipment for wear and alignment
Repair or replace defective parts
Test machine for performance
Make minor adjustments to equipment
Prepare planned maintenance schedules
Explain breakdown maintenance

Competency: Maintain hand tools

Competency Builders:

Demonstrate use and care of measuring devices (e.g., rules, tapes, calipers, micrometers, multimeter, thermometer, and coordinate measuring system)
Demonstrate use and care of equipment used to bend and assemble rigid conduit and tubing
Demonstrate use and care of common hand tools
Demonstrate use and care of wood working tools (e.g., saws, planes, drills, hammers)
Demonstrate use and care of sheet metal tools (e.g., sheet metal gauges, hand seamers, soldering irons)
Demonstrate use and care of ropes, slings, pullers, and block and tackle
Demonstrate proper metal working bench skills (including use of vices, hacksaws, files, tapes, dies, and reamers)
Demonstrate use and care of pipe clearing equipment

Competency: Maintain portable power tools

Competency Builders:

Demonstrate use and care of light-duty and heavy-duty drills
Demonstrate use and care of electric hammers
Demonstrate use and care of pneumatic drills and hammers
Demonstrate use and care of power screwdrivers and impact wrenches
Demonstrate use and care of linear motion saws
Demonstrate use and care of circular saws
Demonstrate use and care of routers and planes
Demonstrate use and care of belt, pad and disc sanders
Demonstrate use and care of grinders and shears
Demonstrate use and care of explosive actuated tools
Demonstrate use and care of electric lifts

Competency: Maintain stationary equipment

Competency Builders:

Demonstrate use and care of mechanical presses
Demonstrate use and care of hydraulic presses
Demonstrate use and care of drill presses
Demonstrate use and care of bench grinders
Demonstrate use and care of power saws (e.g., hack, cut-off, chop, band, jig, and table)
Demonstrate use and care of band saws
Demonstrate use and care of pipe threaders
Demonstrate use and care of metal brakes
Demonstrate use and care of power shears

Unit: Basic Materials Science

Competency: Demonstrate basic knowledge of metallurgy

Competency Builders:

Define metallurgy
Define metal forming (e.g., general process)
Identify forming industries (e.g., stamping, forging, fabricating)
Describe metal forming principles
Describe the metal forming process
Identify frequently used metals
Describe the crystalline structures of metals
Use periodic chart to evaluate metals
List chemical properties of common metals
List physical properties of common metals
Describe measures of metal strength
Identify examples of raw materials processed by hot rolling, cold rolling, forging, drawing, extrusion, spinning and powered metallurgy
Explain secondary finishing operations (e.g., paint, anodizing)

Competency: Demonstrate basic knowledge of heat treatment

Competency Builders:

Describe process of heat treating
Define types of heat treating (e.g., case hardening, annealing, drawing, stress relieving, tempering, quenching, critical temperature)

Competency: **Demonstrate basic knowledge of metal characteristics and formability**

Competency Builders:

Explain metal and formability basics
Explain metal grades and coatings
Explain part contour analysis
Explain tensile test
Explain LDH test
Explain bend test
Explain hold expansion test
Explain R-value test
Explain hardness test
Explain cup test
Explain friction test
Explain surface test
Explain interpretation of metal characteristics tests
Describe blank/die interactions (e.g., friction)
Describe friction and forming process
Describe circle grid basics
Describe circle grid applications
Describe formability diagnostics
Describe the documentation process

Competency: **Demonstrate basic knowledge of casting**

Competency Builders:

Identify frequently used metals
Describe crystalline structures of metals
Use periodic chart in evaluating metals
List chemical properties of common metals
List physical properties of common metals
Define permanent mold casting
Define shell mold casting
Define sand casting and pattern making
Define die casting
Identify basic casting terms
Identify advantages/disadvantages of casting processes

Competency: **Demonstrate basic knowledge of iron and its alloys**

Competency Builders:

Define iron and its alloys
Describe iron manufacturing process
Describe the structure of iron and its alloys
List chemical properties of iron and its alloys
List physical properties of iron and its alloys
Describe iron and alloys property variables
Describe measures of strength for iron and its alloys
Identify examples of iron and its alloys processed by hot rolling, stamping, cold rolling, drawing, extrusion, spinning, casting, forging and machining
Perform tensile test
Perform Brinell test
Perform chemical analysis

Competency: **Demonstrate basic knowledge of aluminum and its alloys**

Competency Builders:

Define aluminum and its alloys
Describe aluminum manufacturing process
Describe the structure of aluminum
List chemical properties of aluminum
List physical properties of aluminum
Describe aluminum property variables
Identify examples of aluminum processed by cold rolling, drawing, extrusion, stamping, spinning, casting, forging and machining
Perform tensile test
Perform Brinell test
Perform chemical analysis

Competency: **Demonstrate basic knowledge of copper and its alloys (e.g., brass, bronze)**

Competency Builders:

Define copper and its alloys
Describe copper manufacturing process
Describe the structure of copper
List chemical properties of copper
list physical properties of copper
Describe copper property variables
Describe measures of copper strength
Identify examples of copper processed by cold rolling, drawing, extrusion, stamping, spinning, casting, forging and machining
Perform tensile test
Perform Brinell test
Perform chemical analysis

Competency: **Demonstrate basic knowledge of plastics and polymers**

Competency Builders:

Define thermo-analysis testing (e.g., melt flow, moisture control)
Define plastics and polymers
Describe plastics and polymers manufacturing processes
Describe structure of plastics and polymers
List chemical properties of plastics and polymers
List physical properties of plastics and polymers
Differentiate thermoset and thermoplastic
Describe plastics and polymer property variables
Describe measure of plastic and polymer strength
Identify examples of raw materials processed by machining, extrusion, stamping, injection molding, compression molding and injection compression molding
Identify molding defect (e.g., flash, sink marks, warp, contamination, wet material, stuck parts, short shot, burn marks, surface blemishes)
Identify secondary operations performed on plastic parts (e.g., plating, milling, painted)
Perform tensile test
Perform R-value test

Competency: Demonstrate basic knowledge of concrete and other ceramics

Competency Builders:

Explain concrete tools and applications (e.g., float, chairs)
Describe the formation of concrete
List types of cements and their uses
Define qualities of concrete (i.e., strength, consistency, homogeneity, tensile force, abrasion, heat of hydration, and heat and sulfate resistance)
List tests used in concrete production (e.g., slump test, test of fineness modules)
List protective practices used after pouring

Competency: Demonstrate knowledge of corrosion and protection

Competency Builders:

Identify causes of corrosion
Identify types of corrosion
List solutions to minimize problems
Identify corrosion testing

Competency: Demonstrate basic knowledge of rubber manufacturing

Competency Builders:

Explain history of rubber industry
Compare properties of natural rubber with those of synthetic rubber
Explain how natural rubber is manufactured
Explain vulcanizaton, mastication, and cure systems
Explain use of compounding ingredients (e.g., carbon blacks, accelerators, fillers, antioxidants)
Explain press and autoclave curing
Explain how synthetic rubber is manufactured (e.g., neoprene, butyl, styrene-butadiene)
Explain rubber testing (e.g., tensile, durometer)

Unit: Welding Basics

Competency: Perform basic gas welding, brazing, and cutting

Competency Builders:

Follow safety guidelines
Differentiate welding and brazing
Identify gas welding and cutting equipment and accessories
Use personal protective equipment required for welding and cutting
Explain capillary attraction as it applies to metal
Demonstrate proper lighting, adjusting, and shutting down of gas torch
Layout mild steel
Cut mild steel
Braze mild steel
Solder non-ferrous metals
Apply basic metallurgy technology

Competency: Perform basic arc welding/cutting (i.e., stick)

Competency Builders:

Identify arc welding equipment and accessories
Explain process of resistance welding
Explain process of projection welding
Explain process of flash-butt welding
Explain process of laser welding
Explain process of friction welding
Explain process of spot welding
Explain process of shielded metal-arc welding (SMAW)
Explain process of gas metal-arc welding (GMAW)
Explain process of gas tungsten-arc welding (GTAW)
Explain process of plasma-arc cutting
Explain process of carbon arc gouging and cutting
Explain process of welding plastics
Explain welding rod alloys
Read welding rods
Explain mild steel welding rod
Explain low hydrogen welding electrode
Explain rationale for preheating and post-heating metal
Explain (GMAW) welding in flat, horizontal, vertical positions
Explain (GTAW) welding on mild steel, stainless steel, and aluminum
Explain process of build up and hard facing
Troubleshoot fusion of materials
Weld stainless steel using (SMAW) process
Weld steel requiring preheat
Weld cast iron
Weld aluminum
Apply basic metallurgy technology

Unit: Polymeric Testing

Competency: Demonstrate knowledge of polymeric testing

Competency Builders:

List reasons to test polymers
Explain purpose of standards
Identify factors affecting test results
Identify principles of conditioning

Competency: Apply instrumental methods of analysis

Competency Builders:

Explain linear regression and its uses
Explain purposes of instrumental analysis
Explain precision and error analysis
Explain atomic absorption
Use spectroscopic methods
Use thermal analysis methods
Use chromatographic methods
Use microscopy
Use non-destructive testing methods (e.g., acoustic, strain gauges)

Competency: Perform analytical testing of polymeric materials

Competency Builders:

Identify plastics by trade name and heat reaction
Analyze products by functional requirements
Describe plastics by appearance
Identify plastics by reaction to solvents
Dissect products
Test amorphous and crystalline plastics
Flame test plastics
Identify the burning rates of plastics
Identify the softening point of plastics
Deformation test plastics
Identify specific gravity determinations
Identify specific gravity using density gradient
Identify specific gravity using Jolly Balance
Calculate particle size
Use Melt Index
Identify ash content of thermosetting plastics
Test to document effects of additives on plastics
Extract plasticziers from polyvinyl chloride

Competency: Test polymeric materials for hardness and impact

Competency Builders:

Identify principles of hardness testing
Perform failure analysis
Use shore A & D Durometers
Test with Clark hardness tester
Define the Law of Conservation of Energy
Use Charpy/Izod Impact tester
Perform permeation testing
Identify principles of falling dart impacting
Use Film Dart Impact tester
Perform creep and creep-rupture testing
Explain use of abrasion and friction testing

Competency: **Tensile test polymeric materials**

Competency Builders:

Explain polymer stress and strain
Use tensometer
Use rheometer
Identify modules of elasticity
Use tear tester
Test for stiffness and resilience of polymeric materials

Competency: **Describe effects of weathering and aging on polymeric materials**

Competency Builders:

Explain the purpose of weathering/aging tests
Explain the theory of accelerated testing
Perform water absorption tests
Explain water absorption properties of plastics
Explain thermal expansion of plastics
Compare test results performed under different laboratory conditions

TECH PREP

"GET SERIOUS . . . ABOUT SUCCESS"

Computer Systems Technician

Units to Consider: Page

Communications Literacy CS-1
Mathematics Literacy CS-12
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—NOTICE—

Each Tech-Prep Competency Profile developed should respond to the labor market demands of your Tech Prep Consortium. Therefore, the following pages should be examined carefully before being selected for use in TCP Part I. **[See "The TCP Process" for more information.]** For example, in some cases the number of units far exceeds the amount of content that can be covered within a 4 + 2 TPAD Program. All the units listed in this section will not necessarily apply to your situation, nor will all the competencies within each unit be appropriate. Note that several units appear within each specific occupation and would need to only appear once if you are compiling a cluster of occupations. **[See "TCP Matrix" and "How to Use the TCP Binder" for more information.]**

Unit: Communications Literacy

NOTE: This content was extracted from the 9-12 cluster of Ohio's Model Language Arts Program. Due to statewide initiatives other than Tech Prep, this literacy unit was not altered to meet competency-based criteria. Each literacy unit forms a critical link between academic teachers and members of business, industry, and labor. [See "The TCP Process" for more information.]

Subunit: Reading—Structure

Competencies:

RS1	Exhibit knowledge of language structure
RS2	Recognize that there may be more than one interpretation of reading selections
RS3	Recognize various literary devices
RS4	Recognize and discuss literary elements
RS5	Develop and use an increasingly sophisticated vocabulary gained through context
RS6	Apply knowledge of language structure to reading
RS7	Explain why there may be more than one interpretation of reading selections
RS8	Recognize effect of literacy devices on meaning
RS9	Analyze author's use of literary elements
RS10	Recognize relationship of structure to meaning
RS11	Describe various interpretations and meaning levels in reading selections
RS12	Characterize author's use of literary devices
RS13	Characterize use of literary techniques
RS14	Critique a variety of literature with regard to plot, dialogue, theme, setting, and characterization
RS15	Apply an expanding vocabulary gained through reading
RS16	Explain various interpretations and meaning levels in reading selections
RS17	Analyze use of literary techniques (e.g., extended metaphor, simile, personification, hyperbole, pun, alliteration)
RS18	Understand use of literary devices (e.g., irony, satire, allegory, onomatopoeia)
RS19	Analyze and synthesize pieces of literature with regard to plot, dialogue, theme, setting, and characterization

Subunit: Reading—Meaning Construction
Competencies:

RM1	Demonstrate ability to recognize appropriate pre-reading strategies
RM2	Describe effectiveness of a reading selection
RM3	Read to clarify personal thinking and knowledge
RM4	Support interpretation of text by locating and citing specific information
RM5	Develop personal response to a variety of literary works
RM6	Recognize diverse literary interpretations
RM7	Engage in self-selected reading activities
RM8	Confirm and extend meaning in reading by researching new concepts and facts
RM9	Self-monitor and apply corrective strategies when communication has been interrupted or lost
RM10	Use features of literary genres to extend meaning
RM11	Assess effectiveness of a selection read
RM12	Use reading as a possible problem-solving strategy to clarify personal thinking and knowledge
RM13	Use knowledge of semantic elements (e.g., figurative language, denotation, connotation, dialect) to clarify meaning when reading
RM14	Predict, recognize, interpret, and analyze themes based on familiarity with author's work
RM15	Compare and contrast literary genres
RM16	Assess validity and quality of selection read
RM17	Clarify meaning when reading
RM18	Compare personal reaction to critical assessment of a literary selection
RM19	Assess validity of diverse literary interpretations
RM20	Use reference books to find, evaluate, and synthesize information
RM21	Identify tone of a literary work
RM22	Critique validity of diverse literary interpretations
RM23	Integrate personal reaction to and critical assessment of a literary selection

Subunit: Reading—Application
Competencies:

RA1 Select and read material for personal enjoyment and information
RA2 Read a variety of complete, unabridged works
RA3 Employ various reading strategies according to purpose
RA4 Participate in selection of books, materials, and topics for literature study groups
RA5 Develop and apply knowledge of the interrelationship of concepts
RA6 Read selections from a variety of styles and formats, recognizing that style and format influence meaning
RA7 Extend value of reading, writing, speaking, viewing, and listening by pursuing, through reading, new concepts and interests developed as a result of these activities
RA8 Read extensively from a particular author's work and explain elements
of author's style

Subunit: Reading—Multidisciplinary
Competencies:

RM1 Connect themes and ideas across disciplines through literature
RM2 Read to facilitate learning across curriculum
RM3 Read to develop awareness of human rights and freedom
RM4 Participate actively in a community of learners
RM5 Recognize and explain interaction between literature and various cultural domains (e.g., social technological, political, economic)
RM6 Explore and analyze a variety of cultural elements, attitudes, beliefs, and value structures by men and women of many racial, ethnic, and cultural groups
RM7 Value thinking and language of others
RM8 Relate literature to historical period about which or in which it was written
RM9 Read to facilitate content learning

Subunit: Writing—Structure

Competencies:

WS1 Develop and expand a repertoire of organizational strategies (e.g., narration, comparison/contrast, and description) through a practice and discussion
WS2 Clarify word choice according to audience, topic, and purpose
WS3 Locate and correct errors in usage, spelling, and mechanics using a variety of resources
WS4 Recognize information gained from primary and secondary sources
WS5 Develop writing which contains ordered, related, well-developed paragraphs with sentences of varied lengths and patterns
WS6 Use information from a variety of sources to develop an integrated piece of writing
WS7 Evaluate and revise writing to focus on such things as audience, tone, and purpose
WS8 Recognize differences between documentation and reference list styles
WS9 Develop extended pieces of writing which contain ordered, related, well-developed paragraphs with sentences of varied lengths and patterns
WS10 Select from a repertoire of organization strategies a pattern appropriate to a topic
WS11 Synthesize information from a variety of sources
WS12 Refine word choice and tone according to audience, situation, and purpose
WS13 Appropriately cite information gained from primary and secondary sources
WS14 Use style manuals or software to prepare documentation and reference lists
WS15 Develop effectively organized pieces of expository writing containing strong voice, clear thesis, and well-developed ideas
WS16 Identify organization patterns appropriate to writing topic
WS17 Respond to others' suggested revisions to a writing piece

Subunit: Writing—Meaning Construction

Competencies:

WM1	Demonstrate knowledge of the recursive nature of the writing process by applying it appropriately to various topics, situations, and audiences
WM2	Develop criteria for writing evaluation using scoring guides and peer/teacher assistance to clarify meaning
WM3	Respond to others' suggested revisions to a piece of writing
WM4	Use word processing, graphics, and publishing aids to construct meaning in writing
WM5	Engage in self-initiated writing activities
WM6	Incorporate personal criteria with generally accepted standards for writing evaluation
WM7	Evaluate, analyze, and synthesize information for writing
WM8	Evaluate own writing using personal and established scoring criteria
WM9	Assess personal/peer revisions to a writing piece
WM10	Recognize and refine personal writing styles

Subunit: Writing—Application
Competencies:

WA1 Apply appropriate writing techniques suitable for varied writing tasks
WA2 Use sentence-combining techniques to improve syntactic fluency and maturity
WA3 Write in response to prompted and self-selected topics in practical, persuasive, descriptive, narrative, and expository domains
WA4 Develop personal voice in writing
WA5 Consider audience and purpose for writing
WA6 Develop criteria for selection and potential development of topic
WA7 Write in a journal or learning log to clarify personal thinking and knowledge
WA8 Apply an expanding vocabulary gained through writing
WA9 Make judicious use of reference sources (e.g., dictionary, thesaurus, on-lien data base, encyclopedia)
WA10 Demonstrate, an appreciation for aesthetically pleasing language through word choice and style
WA11 Apply revising and editing strategies needed for writing task
WA12 Vary sentence lengths and patterns
WA13 Refine personal voice in writing
WA14 Vary styles and formats for intended purpose and audience
WA15 Apply criteria for selection and development of topic
WA16 Participate in peer review of writing in progress
WA17 Use transitions between sentences, ideas, and paragraphs in writing
WA18 Revise and edit papers extensively in preparation for presentation/publication
WA19 Develop a variety of genres
WA20 Focus writing and tone on such elements as audience, situation, and purpose
WA21 Develop topic fully and appropriately
WA22 Use writing process to clarify personal thinking and knowledge
WA23 Apply appropriate recursive writing process as suggested by writing task and writer's process
WA24 Develop an extended piece of writing
WA25 Revise writing and tone to assure focus on such elements as audience, situation, and purpose
WA26 Use writing process to write reflectively

Subunit: Writing—Multidisciplinary

Competencies:

WM1	Use writing process for learning across curriculum
WM2	Use writing process to demonstrate knowledge of need for human rights and freedom
WM3	Value and apply collaborative skills in writing process
WM4	Write in response to reading, speaking, viewing, and listening
WM5	Use multidisciplinary resources in writing projects
WM6	Use writing process to facilitate learning across curriculum
WM7	Recognize value of and engage in collaboration in writing process
WM8	Use communication processes to develop a published writing piece in collaboration with others
WM9	Record experiences and observations related to content learning
WM10	Apply collaborative skills in writing process
WM11	Write collaboratively with peers
WM12	Use cross-disciplinary resources in writing projects

Subunit: Listening/Visual Literacy—Structure

Competencies:

LS1	Listen to and view a wide variety of genres
LS2	Become aware of an author's style through listening and viewing a variety of works
LS3	Recognize correct and appropriate grammar, diction, and syntax
LS4	Expand vocabulary through listening to and viewing varied media
LS5	Recognize beauty of language
LS6	Enhance recognition of an author's style through listening and viewing a variety of works
LS7	Recognize use and misuse of language in media
LS8	Refine knowledge of style through listening and viewing multiple works by the same author
LS9	Expand and refine grammar, diction, and syntax through listening
LS10	Compare authors' styles through viewing and listening to their works
LS11	Expand knowledge of complex grammar, diction, and syntax issues

Subunit: Listening/Visual Literacy—Meaning Construction

Competencies:

LM1 Develop critical thinking skills necessary to evaluate media and assess oral presentations
LM2 Compare new oral texts to past experiences and knowledge in order to enhance comprehension
LM3 Recognize how rhythmic patterns, silence, and cadences enhance quality of speech and literature
LM4 Focus listening and viewing on themes and/or plots
LM5 Gather information from listening and viewing experiences to enhance research
LM6 Use critical thinking skills to evaluate media and oral presentations
LM7 Use prior knowledge and experiences to facilitate comprehension of new oral texts
LM8 Identify rhythmic and time patterns in speech and literature
LM9 Identify and analyze themes and/or plots when listening and viewing
LM10 Use information gathered from listening and viewing experiences to expand research
LM11 Enhance use of critical thinking skills to evaluate media and oral presentations
LM12 Consider prior knowledge and experiences when attempting to understand the meaning of new texts
LM13 Appreciate rhythmic and time patterns of speech and literature
LM14 Select viewing and listening materials to support written text
LM15 Evaluate media and oral presentations analytically and critically
LM16 Organize prior knowledge and experiences to comprehend new texts
LM17 Organize and use viewing and listening materials to support written text

Subunit: Listening/Visual Literacy—Application

Competencies:

LA1 Listen attentively during oral reading
LA2 Use media as stimuli for learning and thinking
LA3 Develop knowledge of structure through art, music, and literature
LA4 Use electronic media to enhance and highlight language learning
LA5 Listen and view for entertainment and enjoyment
LA6 Use technology and other media as means of expressing ideas

Subunit: Listening/Visual Literacy—Multidisciplinary Competencies:

LM1 Facilitate learning across curriculum through critical listening and viewing
LM2 Engage in individual, small-group, and whole-group listening and viewing activities
LM3 Develop language arts (e.g., viewing, listening) projects collaboratively
LM4 Investigate language and cultural differences through listening and viewing activities
LM5 Participate in a community of learners through productive listening

Subunit: Oral Communication—Structure Competencies:

OS1 Refine oral communication skills
OS2 Demonstrate knowledge of grammar, usage, and syntax when presenting
OS3 Select topics and vocabulary suitable to audience
OS4 Organize notes and ideas for speaking
OS5 Use language imaginatively
OS6 Modulate voice to meaning when interpreting literature orally
OS7 Organize notes and ideas for formal, semiformal and informal presentations of information
OS8 Refine speaking techniques for formal, semiformal, and informal settings
OS9 Develop repertoire of organizational strategies for presenting information orally
OS10 Expand vocabulary to fit topic
OS11 Select topics suitable to audience, situation, and purpose
OS12 Select appropriate strategies when organizing notes and ideas for speaking

Subunit: Oral Communications—Meaning Construction

Competencies:

OM1 Make connections between prior knowledge and new information for oral presentations
OM2 Participate in informal speaking activities
OM3 Use interviewing techniques to gather information
OM4 Communicate orally to entertain and to inform
OM5 Participate in group communication activities
OM6 Take and organize notes when preparing speech/presentation
OM7 Interpret texts orally to illustrate meaning
OM8 Respond to needs of various audiences
OM9 Gather and assess information for speaking
OM10 Communicate orally to inform and persuade
OM11 Prepare and deliver formal speech/presentation
OM12 Participate in a variety of oral interpretations
OM13 Assess needs of audience and adjust language and presentation according to their knowledge
OM14 Analyze and synthesize information for speaking
OM15 Describe effectiveness of literary selection
OM16 Describe topic or idea in order to clarify personal/audience thinking
OM17 Analyze and synthesize information gathered from a variety of sources for speaking
OM18 Describe validity and/or quality of a literary selection and justify selection
OM19 Interpret orally a variety of literature
OM20 Describe topic or idea to clarify meaning for others

Subunit: Oral Communication—Application

Competencies:

OA1 Become proficient at using interviewing techniques
OA2 Give an oral interpretation for a specific audience
OA3 Develop and apply oral communication skills for cooperative/collaborative learning
OA4 Use oral communication for a variety of purposes and audiences (e.g., negotiations, book reviews, rationales)
OA5 Develop and apply decision-making strategies
OA6 Practice interviewing techniques
OA7 Apply interviewing techniques to purposeful interviews
OA8 Focus oral interpretation on a specific audience

Subunit: Oral Communications—Multidisciplinary

Competencies:

OM1	Value thinking and language of others
OM2	Develop oral projects collaboratively
OM3	Be involved in individual, small-group, and whole-group language activities
OM4	Participate actively in a community of learners
OM5	Investigate language and cultural differences through oral language activities

Unit: Mathematics Literacy

NOTE: This content was extracted from the 9-12 cluster of Ohio's Model Mathematics Program. Due to statewide initiatives other than Tech Prep, this literacy unit was not altered to meet competency-based criteria. Each literacy unit forms a critical link between academic teachers and members of business, industry, and labor. [See "The TCP Process" for more information.]

Subunit: Numbers and Number Relations
Competencies:

NR1	Compare, order, and determine equivalence of real numbers
NR2	Estimate answers, compute, and solve problems involving real numbers
NR3	Compare and contrast real number system, rational number system, and whole number system
NR4	Extend knowledge to complex number system and develop facility with its operation

Subunit: Measurement
Competencies:

M1	Estimate and use measurements
M2	Understand need for measurement and probability that any measurement is accurate to some designated specification
M3	Understand and apply measurements related to power and work
M4	Understand and apply measurement concepts of distance-rate-time problems and acceleration problems
M5	Use real experiments to investigate elasticity, heat, sound, electricity, magnetism, light, acceleration, velocity, energy, and gravity
M6	Use real-world problem situations involving mass and weight
M7	Use real-world problem situations involving simple harmonic motion
M8	Establish ratios with and without common units
M9	Construct and interpret maps, tables, charts, and graphs as they relate to real-world mathematics
M10	Understand and solve rate-change problems
M11	Understand and solve right triangle relationships as they relate to measurement, specifically to Pythagorean theorem
M12	Graph and interpret ordered pairs
M13	Compute total sales from a variety of items
M14	Comprehend and compute rates of growth or decay
M15	Comprehend, compute, and interpret real problems involving annuities

Subunit: Measurement (continued)
Competencies:

M16 Develop an ability to identify real problems and provide possible solutions
M17 Express and apply different types of measurement scales
M18 Identify area and volume

Subunit: Estimation and Mental Computation
Competencies:

E1 Use estimation to eliminate choices in multiple-choice tests
E2 Use estimation to determine reasonableness of problem situations in a wide variety of applications
E3 Estimate shape of graphs of various functions and algebraic expressions
E4 Use mental computation when computer and calculator are inappropriate

Subunit: Data Analysis and Probability
Competencies:

D1 Organize data into tables, charts, and graphs
D2 Understand and apply measures of central tendency, variability, and correlation
D3 Use curve fitting to predict from data
D4 Use experimental or theoretical probability, as appropriate, to represent and solve problems involving uncertainty
D5 Use computer simulations and random number generators to estimate probabilities
D6 Test hypotheses using appropriate statistics
D7 Read, interpret, and use tables, charts, and graphs to identify patterns, note trends, draw conclusions, and make predictions
D8 Identify probabilities of events involving unbiased objects
D9 Use sampling and recognize its role in statistical claims
D10 Design a statistical experiment to study problem, conduct experiment, and interpret and communicate outcomes
D11 Describe normal curve in general terms and use its properties
D12 Create and interpret discrete probability distributions
D13 Understand concept of random variable
D14 Apply concept of random variable to generate and interpret probability distributions, including binomial, uniform, and chi square

Subunit: Algebra
Competencies:

A1 Describe problem situations by using and relating numerical, symbolic, and graphical representations
A2 Use language and notation of functions in symbolic and graphing settings
A3 Recognize and use equivalent zeros of a function, roots and the solution of an equation in terms of graphical and symbolic representations
A4 Describe and use logic of equivalence in working with equations, inequalities, and functions
A5 Develop graphical techniques of solution for problem situations involving functions
A6 Explore and describe characterizing features of functions
A7 Make arguments and proofs in algebraic settings
A8 Factor difference of two squares
A9 Identify slope, midpoint, and distance
A10 Explore and combine rational functions
A11 Explore factoring techniques
A12 Solve quadratic equations by factoring and formula
A13 Set up and solve linear equations
A14 Solve systems of linear equations with two variables
A15 Describe geometric situations and phenomena using variables, equations, and functions
A16 Describe measures of central tendency, mean, median, mode, and variance algebraically and graphically
A17 Represent inequalities on number line and in coordinate plane
A18 Use coordinate arguments in making geometric proofs
A19 Symbolize transformations of figures and graphs
A20 Explore geometric basis for functions of trigonometry
A21 Graph linear functions
A22 Develop and use vectors to represent direction and magnitude including operations
A23 Use polar and parametric equations to describe, graph, and solve problem situations
A24 Represent sequences and series as functions both algebraically and graphically
A25 Explore recursive functions and procedures using spreadsheets, other computer utilities, and appropriate notions
A26 Describe and solve algebraic situations with matrices
A27 Describe and use inverse relationship between functions including exponential and logarithmic

Subunit: Algebra (continued)
Competencies:

A28 Analyze and describe errors and error sources that can be made when using computers and calculators to solve problems
A29 Decide whether problem situation is best solved using computer, calculator, paper and pencil, or mental arithmetic/estimation techniques
A30 Explore relationships between complex numbers and vectors
A31 Make arguments concerning limits, convergence and divergence in context involving sequences, series, and other types of functions
A32 Represent transformations in plane with matrices
A33 Contrast and compare algebra's of rational, real, and complex numbers with characteristics of a matrix algebra system
A34 Construct polynomial approximations of a function over specified intervals of convergence
A35 Examine complex numbers as zeros of functions
A36 Translate verbal statements into symbolic language
A37 Simplify algebraic expressions
A38 Use laws and exponents (including scientific notation)
A39 Expand and extend idea of vectors and linear algebra to higher dimensional situations
A40 Use the idea of independent basis elements for a vector space and associated fundamental concepts of finite dimensional linear algebra
A41 Develop and communicate arguments about limit situations
A42 Use matrices to describe and apply transformations
A43 Develop and use polar and parametric equations to represent problem situations
A44 Explore proofs by mathematical induction

Subunit: Geometry
Competencies:

G1	Create and interpret drawings of three-dimensional objects
G2	Represent problem situations with geometric models and apply properties of figures
G3	Apply Pythagorean theorem
G4	Demonstrate knowledge of angles and parallel and perpendicular lines
G5	Explore inductive and deductive reasoning through applications to various subject areas
G6	Translate between synthetic and coordinate representations
G7	Identify congruent and similar figures using transformation with computer programs
G8	Deduce properties of figures using transformations and coordinates
G9	Use deductive reasoning
G10	Explore compass and straightedge constructions in context of geometric theorems
G11	Demonstrate knowledge of and ability to use proof
G12	Use variety of proof techniques (e.g., synthetic, transformational, and coordinate)
G13	Use variety of proof formats, including T-proof (i.e., two-column) and paragraph proof
G14	Explore different proof strategies
G15	Investigate different proofs of theorems
G16	Develop knowledge of an axiomatic system
G17	Apply transformations and coordinates in problem solving
G18	Represent problem situations with geometric models and apply properties of figures
G19	Deduce properties of figures using vectors
G20	Analyze properties of Euclidean transformations and relate translations to vectors
G21	Apply vectors in problem solving
G22	Develop further knowledge of axiomatic systems by investigating and comparing various geometry's

Subunit: Patterns, Relations, and Functions
Competencies:

P1 Model real-world phenomena with polynomial and exponential functions
P2 Explore relationship between zeros and intercepts of functions
P3 Translate among tables, algebraic expressions, and graphs of functions
P4 Use graphing calculator or computer to generate graph of a function
P5 Explore relationship between a linear function and its inverse
P6 Describe and use characteristics of polynomial functions in problem-solving situations
P7 Explore conic sections and graph using graphing calculator or computer
P8 Apply trigonometric functions to problem situations involving triangles
P9 Discover relationships between algebraic description, kind, and properties of conic
P10 Explore periodic real-world phenomena using sine and cosine functions
P11 Analyze effects of parameter changes on graphs
P12 Use graphing calculator or computer to graph functions
P13 Develop an knowledge of rational and transcendental functions
P14 Understand connections between trigonometric and circular functions
P15 Use circular functions to model periodic real-world functions
P16 Solve trigonometric equations and verify trigonometric identities
P17 Understand connections between trigonometric, exponential, and logarithmic functions and polar coordinates, complex numbers, and series
P18 Model real-world phenomena with a variety of functions
P19 Graph using polar coordinates
P20 Explore graphs in three dimensions
P21 Explore functions of several variables
P22 Explore recursive functions using spreadsheets and/or programming languages

Unit: Science Literacy

NOTE: This content was extracted from the 9-12 cluster of Ohio's Draft Model Science Program. Due to statewide initiatives other than Tech Prep, this literacy unit was not altered to meet competency-based criteria. Each literacy unit forms a critical link between academic teachers and members of business, industry, and labor. [See "The TCP Process" for more information.]

Subunit: Scientific Inquiry

Competencies:

Q1 Check the appropriateness and accuracy of measures and computations using various strategies (e.g., estimations, unit analysis, determination of significant figures)

Q2 Use ratios, proportions, and probabilities in appropriate problem situations

Q3 Translate information from and represent information in various forms with equal ease (e.g., tables, charts, graphs, diagrams, geometric figures)

Q4 Use existing algebraic formulas and create new ones in appropriate problem-solving situations

Q5 Estimate and justify probabilities of outcomes of familiar situations based on experimentation and other strategies

Q6 Invent apparatus and mechanical tools needed to perform unique tasks in various situations

Q7 Identify, compare, and contrast different modes of inquiry, habits of mind, and attitudes and dispositions

Q8 Design investigations that are safe and ethical (i.e., obtain consent and inform others of potential outcomes, risks and benefits, and show evidence of concern for human health and safety, concern for non-human species)

Q9 Make and read scale drawings, maps, models, and other representations to aid planning and understanding

Q10 Seek elaboration and justification of data and ideas, and reflect on alternative interpretations of the information

Q11 Use appropriate units for counts and measures

Q12 Create and use databases (electronic and other) to collect, organize, and verify data and observations

Q13 Design and conduct investigations with multiple variables

Q14 Communicate the results of investigations clearly in a variety of situations

Subunit: Scientific Inquiry (continued)
Competencies:

Q15 Examine relationships in nature, offer alternative explanations for the observations, and collect evidence that can be used to help judge among explanations

Q16 Trace the development (e.g., history, controversy, and ramifications) of various theories, focusing on supporting evidence and modification with new evidence

Q17 Select, invent, and use tools, including analog and digital instruments, to make and record direct measurements

Q18 Observe and document events and characteristics of complex systems

Q19 Explain the influence of perspective (e.g., spatial, temporal, and social) on observation and subsequent interpretations

Q20 Create multiple representations of the same data using a variety of symbols, descriptive languages, mathematical concepts, and graphic techniques

Q21 Generate testable hypotheses for observations of complex systems and interactions

Q22 Document potentially hazardous conditions and associated risks in selected homes and public areas

Q23 Participate in public debates, relying on documented and verified data to construct and represent a position on scientific issues

Q24 Construct and test models of physical, biological, social, and geological systems

Q25 Read, verify, debate, and, where necessary, refute research published in popular or technical journals of science (e.g., *Discover*, *Omni*, *Popular Mechanics*)

Q26 Explore discrepant events and develop and test explanations of what was observed

Q27 Conduct theory-based research using surveys, observational instruments, and other methods

Q28 Modify personal opinions, interpretations, explanations, and conclusions based on new information

Q29 Analyze error and develop explanations in various domains

Q30 Formulate taxonomic schemes based upon multivariate models that help to explain similarities and differences in form, distribution, behavior, survival, and origin of objects and organisms

Q31 Demonstrate various logical connections between related concepts (e.g., entropy, conservation of energy)

Q32 Account for discrepancies between theories and observations

Q33 Analyze the changes within a system when inputs, outputs, and interactions are altered

Subunit: Scientific Inquiry (continued)
Competencies:

Q34 Create, standardize, and document procedures
Q35 Determine the sources of significant disparities between the predicted and recorded results and change research procedures to minimize disparities
Q36 Research, locate, and propose applications for abstract patterns (e.g., fractals, Fibonacci sequences, string theory, orbitals)
Q37 Recognize and utilize classification systems for particles, elements, compounds, phenomena, organisms, and others for exploring and predicting properties and behaviors
Q38 Suggest and defend alternative experimental designs and data explanations (e.g., sampling, controls, safeguards)
Q39 Recognize and communicate differences between questions that can be investigated in a scientific way and those that rely on other ways of knowing
Q40 Draw conclusions based on the relationships among data analysis, experimental design, and possible models and theories
Q41 Suggest new questions as a result of reflection on and discussions about their own scientific investigations
Q42 Investigate, assess, and comment on strengths and weakness of the descriptive and predictive powers of science
Q43 Create new information from representations of data in a variety of forms (e.g., symbols, descriptive languages, graphic formats) utilizing a variety of techniques (e.g., interpolations, extrapolations, linear regressions, central tendencies, correlation's)

Subunit: Scientific Knowledge
Competencies:

K1 Investigate various types of dynamic equilibrium (e.g., biological, geological, mechanical, chemical)

K2 Investigate the relationship between the rates of energy exchange and the relative energy level of components with systems (e.g., tropic levels of ecosystems, osmosis, rate of heating and cooling, storms)

K3 Investigate patterns in the natural world (e.g., heredity, crystalline structures, population and resource distributions, diffraction, dispersion, polarization)

K4 Investigate models and theories that help to explain the interactions of components in systems (e.g., conservation of mass, energy, and momentum; food webs; natural selection; entropy; plate tectonics; chaos; relativity; social-psychology)

K5 Investigate degrees of kinship among organisms and groups of organisms

K6 Investigate the limits of the definition of life, and investigate organisms and physical systems that exist at or near these limits (e.g. viruses, quarks, black holes)

K7 Investigate estimates and measurements of a wide range of distances and rates of change

K8 Investigate the historical development of theories of change over time (e.g., natural selection, continental drift, the big bang, geologic change)

K9 Investigate physical and chemical changes in living and non-living systems (e.g., photosynthesis, weathering processes, glaciation, thermal effects of materials, energy cells)

K10 Investigate simulations of nuclear change (e.g., radioactivity, half life, carbon dating)

K11 Investigate conservation principles associated with physical, chemical, and nuclear changes

K12 Formulate descriptions of the impacts of various forms of mechanical and electromagnetic waves on various organisms on each other over time

K13 Formulate models and hypotheses for patterns in the natural world (e.g., earth structures, transportation systems, migrations, communications, constellations)

K14 Formulate explanations for the influences of objects and organisms on each other over time

K15 Formulate and interpret explanations for change phenomena (e.g., mass extinction's, stellar evolution, punctuated equilibrium, molecular synthesis)

Subunit: Scientific Knowledge (continued)
Competencies:

K16 Formulate and interpret explanations for the magnitudes of diversity at different periods of geologic time (e.g., mutation, global cataclysms, continental drift, competition, mass extinction's)

K17 Formulate interpretations of the structure, function, and diversity in a variety of organisms and physical systems (e.g., DNA and RNA variants, nucleons, interaction particles)

K18 Formulate understandings of geologic time (e.g., millennia, periods, epochs)

K19 Formulate an understanding of the historical development of the model of the universe

K20 Formulate explanations and representations of the production, transmission, and conservation of energy in biological and physical systems (e.g., weather, volcanism, earthquakes, electricity, magnetism, cellular respiration)

K21 Formulate models and hypotheses about patterns in the natural world (e.g., social behavior, molecular structure, energy transformation, entropy, randomness, aging, chaos, hormonal cycles)

K22 Formulate interpretations of the relationship between energy exchange and the interfaces between components within systems

K23a Formulate estimations for the range of energies within and between various phenomena (e.g., thermal, electromagnetic, thermonuclear, chemical, electrical)

K23b Formulate explanations for the historical development of descriptions of motions interactions and transformations of matter and energy (e.g., classical Newtonian mechanics, special and general relativity, chaos)

K24 Formulate models that can be used to describe fundamental molecular interactions in living and non-living systems (e.g., cell membranes, semiconductors).

K25 Formulate an understanding of the degree of relationship among organisms and objects based on molecular structure (e.g., proteins, nucleic acids)

K26 Formulate hypotheses and models that may account for observable events (e.g., electricity and magnetism, gravitation, atoms, bonding, chemical reactions, quantum effects, energy flow on biological systems, predator-prey relationships)

K27 Formulate models and hypotheses about change over time (e.g., natural selection, speciation, punctuated equilibrium, phyleytic gradualism, stellar evolution, plate tectonics, radioactive decay, quantum mechanical theory)

Subunit: Scientific Knowledge (continued)
Competencies:

K28 Formulate lists of limitations and propose refinements of standard classification systems (e.g., periodic table, IUPAC, Linnean, standard model)

K29 Formulate specific cases of limitations and possible exceptions of theories and principles regarding the interactions of moving objects and organisms (e.g., fluid flow in vessels, motion near the speed of light, Heisenberg uncertainty principle, meteorological prediction, local variation and diversity, predicting earthquakes, energy transport in cellular respiration)

K30 Formulate plans and contingencies that can be used to accommodate for changes to and stresses on systems (e.g., wildlife and habitat management, corrosion prevention, noise abatement, structure design)

K31 Formulate models of molecular, atomic, ionic, and subatomic structures and the physical and biological implications of these structures (e.g., genes, nucleons, quarks)

K32 Formulate estimates for a wide range of measurements and scales (e.g., angstroms to light years)

K33 Formulate and interpret representations of time from origin to present accounting for phenomena of scale (e.g., smoothness, punctuation's, chaos)

K34 Formulate interpretations of the historical development of various theories of possible causes of diversity among physical and biological phenomena (e.g., the works of Aristotle, Mendel, Darwin, McClintock)

K35 Formulate models and hypotheses that can be used to explain the interactions of components within technological and ecological systems

Subunit: Conditions for Learning Science

Competencies:

C1 Participate actively in dialogue about and resolution of community issues

C2 Assess information from various countries in the original language or translated form to ascertain the perspectives of many cultures

C3 Analyze the scientific ideas presented in science fiction stories and films

C4 Perform and repeat investigations to verify data, determine regularity, and reduce the impact of experimental error

C5 Present the results of investigations in a variety of forums

C6 Contribute to the decisions regarding topics for investigation

C7 Use various creative means to communicate interpretations of scientific ideas, concepts, phenomena, and events

C8 Consider the scientific thinking and language of others

C9 Individually and collaboratively produce clearly written representations of investigative results

C10 Fulfill responsibilities as part of a research group

C11 Select and utilize resources by various criteria (e.g., efficiency, effectiveness, health, safety) that are appropriate to the investigations being conducted by groups

C12 Present persuasive argument based on the scientific aspects of controversial issues

C13 Collect, store, retrieve, and manipulate information with available t technologies alleges that may range from hand processes up through computer applications

C14 Investigate social issues with a scientific perspective (e.g., human rights, wellness, economics, futurism, environmental ethics)

C15 Keep journals of observations and inferences made over an extended period of time and reflecting upon the impact of these recorded ideas on their thinking and actions

C16 Examine the intellect, perspectives, and ethics of notable scientists

C17 Collect and analyze observations made over extended periods of time and compare these to scientific theories

C18 Create presentations of scientific understandings using diverse modes of expressions

C19 Conduct formal scientific debates in the classroom

C20 Wonder about the likelihood of events that may occur by chance or coincidence

C21 Plan and conduct field trips and experiences for small and large groups

C22 Analyze the historical context which leads to and has lead to scientific t theories

Subunit: Conditions for Learning Science (continued)
Competencies:

C23 Seek information on topics of personal scientific interest from a variety of sources
C24 Conduct learner-developed investigations independently and collaboratively over periods of week and months
C25 Listen attentively and critically to presentations of scientific information made by others
C26 Conduct analyses of propaganda related to scientific issues
C27 Perform investigations that require observations over varying periods of time
C28 Experience scientific concepts as interpreted by other cultures through multimedia and local and global specialists
C29 Access appropriate technology to perform complicated, time-consuming tasks
C30 Relate historical accounts of science to the cultural context in which they were written
C31 Work as a contributing member of a collaborative research group
C32 Examine the influences of social and political structures and realities that contribute to inquiry about scientific issues
C33 Use technology (e.g., desktop publishing, teleconferencing, networking) to communicate scientific ideas
C34 Explore and analyze a variety of perspectives on science (e.g., works by men and women of many racial, ethnic, and cultural groups)
C35 Lead groups of learners of various ages in designing, planning, and conducting science activities
C36 Respect the scientific thinking of others and self
C37 Recognize and contrast different epistemologies
C38 Develop possible courses of action in response to scientific issues of local and global concern
C39 Determine the validity of research conclusions in relation to the design, performance, and results
C40 Develop multimedia presentations of group and individual research projects and investigations appropriate for a variety of audiences and forums
C41 Produce interesting and scientifically correct stories and present them using various modes of expression
C42 Reflect on the ideas and content found in their own journal records
C43 Examine ambiguous results and formulate explanations
C44 Recognize and synthesize the contributions to scientific thought of individuals from many cultures

Subunit: Conditions for Learning Science (continued)
Competencies:

C45 Construct models and simulations of the component structures and functions of living and non-living entities
C46 Lead multi-age groups in the examination of and planned resolution for scientific issues
C47 Recognize and choose members of research teams based upon the merit of their ideas and skills
C48 Construct a portfolio of products, documentation, and self-evaluations of his/her own abilities, skills, and experiences
C49 Synthesize scientific information from a variety of sources
C50 Evaluate and prioritize scientific issues based upon risk-benefit analyses
C51 Refining scientific skills from a variety of experiences

Subunit: Applications for Science Learning

Competencies:

A1 Answer student-determined questions by designing databases and drawing inferences from the analyses of the information in these data bases

A2 Make personal behavior decisions by interpreting information that has a scientific basis

A3 Propose courses of action that will validate and demonstrate personal understandings of scientific principles

A4 Guide other learners in their understanding of the interactions of technologies and society at various periods in time

A5 Promote and carry out practices that contribute to a sustainable environment

A6 Study and propose improvements in public services and systems in their community

A7 Choose consumer materials utilizing personal and environmental risk and benefit information

A8 Make inferences and draw conclusions using databases, spreadsheets, and other technologies

A9 Do simple trouble-shooting on common electrical and mechanical s ystems, identifying and eliminating possible causes of malfunctions

A10 Construct devices that perform simple, repetitive actions

A11 Investigate the functionality of various geometric shapes in the natural world and the designed world (e.g., translations from spherical to plane representations cause distortions, triangular shapes contribute to rigidity and stability in structures, round shapes minimize boundary for a given capacity)

A12 Make decisions regarding personal and public health

A13 Evaluate the social and ecological risks and benefits resulting from the use of various consumer products

A14 Analyze the contributions of advances in technology through history to his/her everyday life

A15 Identify and reduce risks and threats to a sustainable environment

A16 Extend the limits of human capabilities using technological enhancements

A17 Use and recognize various propaganda techniques

A18 Solve unique problems using the results of systematic analyses

A19 Choose everyday consumer products that utilize recent innovation and pass appropriate performance criteria

A20 Refine personal career interests through investigations of the diversity of manufacturing, research, service, and invention processes

Subunit: Applications for Science Learning (continued)
Competencies:

A21 Predict and investigate the working of toys and tools while controlling and manipulating variables (e.g., friction, gravity, forces)

A22 Write, follow, modify, and extend instructions (e.g., equations, algorithms, formulas, flow diagrams, illustrations)

A23 Create products, make inferences, and draw conclusions using databases, spreadsheets, and other technologies

A24 Predict various scenarios and propose solutions to community issues using scientific information (e.g., actuarial tables, census data, topographic maps, incidence data, climatic data)

A25 Use scientific evidence to consider options and formulate positions about the health and safety of others and him/herself

A26 Search for, use, create, and store objects and information using various strategies and methods of organization and access

A27 Research and write environmental impact statements of his/her own design

A28 Compare school-based science perspectives with those gained through cutting-edge technological applications

A29 Design management plans for natural and human-altered environments (e.g., woodlots, patios, lots, lawns, farmlands, forests)

A30 Refine personal career interests

A31 Promote public awareness of the interaction of technology with social i issues

A32 Advocate and propose courses of action for local and global scientific issues using global networks

A33 Use appropriate technologies to prepare and present the findings of investigations incorporating tables, graphs, diagrams, and text

A34 Make informed consumer choices by evaluating and prioritizing information, evidence, and strategies

A35 Develop an informed point-of-view that allows for validation or refutation of the scientific statements and claims of advocated before pursuing courses of action (e.g., contributing support, signing petitions, casting votes)

A36 Differentiate between observations and inferences in the exploration of evidence related to personal, scientific, and community issues

A37 Develop and write environmental impact and safety and hygiene management plans

A38 Use technology to collect, analyze, and communicate information (e.g., electronic networks, desktop publishing, remote sensing, graphing calculators, satellite telemetry, and others)

A39 Design, construct, and market inventions

Unit: Technology Literacy

NOTE: Over 500 Ohio business, industry, and labor representatives examined, altered, and then verified the content for this unit during the TCP Process. The original content was extracted from the Report of the Task Force on Technology Competence—Learner Goals for All Minnesotans, published by the Minnesota State Council on Vocational Technical Education. The Technology Literacy unit forms a critical link between all teachers and stresses the importance of technological impact on teaching and learning. [See "The TCP Process" for more information.]

Competencies:

T1 Demonstrate a systems view of technology based on the interdependence of social, political, economic, and ecological systems

T2 Assess the career, family, and personal development implications of technological change

T3 Demonstrate continuous learning via technology

T4 Demonstrate global appreciation for technology's potential effects on cultures, geographic areas, and the environment

T5 Apply historical perspective on technology to the development and use of new technologies

T6 Apply diverse technologies to store, access, process, create, and communicate information needed to solve problems

T7 Apply legal principles and ethical conduct to the use of technology

T8 Demonstrate competency in mathematics, science, social sciences, communication, and computer skills through the analysis, design, and evaluation of technological systems

T9 Analyze the potential of alternative technological systems to solve problems and/or to extend human capabilities

T10 Use a variety of tools, materials, and equipment in solving problems and extending human capabilities

T11 Assess risks and benefits of technological developments from an ecological, economic, social, and political perspective

T12 Value human diversity as part of a team in suggesting, designing, and testing solutions to technological problems

Unit: Employability Skills

Competency: Develop a career plan

Competency Builders:

Identify current interests and aptitudes
Identify common barriers to employment
Describe strategies to overcome employment barriers
Locate resources for finding employment
Research job trends
Identify career options
Identify advantages and disadvantages of career options (in addition to other than monetary)
Identify job requirements
Investigate education/training opportunities
Evaluate personal strengths and weaknesses

Competency: Prepare for employment

Competency Builders:

Identify traditional and non-traditional employment sources
Identify present and future employment opportunities (by geographic location)
Research job opportunities, including non-traditional careers
Compare salary ranges and benefit packages
Compile occupational profile
Identify rights and responsibilities of equal employment opportunity laws
Design resume and cover letter
Target resume
Secure references
Investigate generic and specific employment tests (e.g., civil service exam; drug screening)
Use follow-up techniques to enhance employment potential
Demonstrate legible written communication skills using correct grammar, spelling, punctuation, and concise wording
Describe methods for handling illegal questions on job application forms and during interviews
Write letter of application
Research prospective employer and services performed
Explain critical importance of personal appearance, hygiene, and demeanor
Interpret job description
Demonstrate appropriate interview question and answer techniques
Demonstrate methods for handling difficult interview questions
Evaluate job offers
Write letter of acceptance
Write letter of declination
Demonstrate good listening skills
Ask for the job tactfully
Participate in extracurricular activities (e.g., student government, community projects,)

Competency: Evaluate the importance of self-esteem as an employability skill

Competency Builders:

Identify factors that affect self-esteem
Compare effects of low self-esteem and high self-esteem
Identify strategies to promote positive self-esteem

Competency: Demonstrate job retention skills

Competency Builders:

Identify employer expectations regarding job performance, work habits, attitudes, personal appearance, and hygiene
Exhibit appropriate work habits and attitude
Demonstrate ability to set priorities
Identify behaviors to establish successful working relationships
Identify alternatives for dealing with harassment, bias, and discrimination based on race, color, national origin, sex, religion, handicap, or age
Identify opportunities for advancement
List reasons for termination
List consequences of being absent frequently from job
List consequences of frequently arriving late for work
Demonstrate interpersonal relations skills (i.e., verbal and written)
Demonstrate negotiation skills
Demonstrate teamwork
Follow chain-of-command
Exhibit appropriate job dedication

Competency: Demonstrate knowledge of work ethic

Competency Builders:

Define work ethic
Identify factors that influence work ethic
Differentiate law and ethics
Describe how personal values are reflected in work ethic
Describe how interactions in the workplace affect personal work ethic
Describe how life changes affect personal work ethic

Competency: Exhibit appropriate work ethic

Competency Builders:

Use time-management techniques
Avoid personal activity during work hours
Attend work as scheduled
Adhere to company and/or governmental policies, procedures, rules, and regulations
Exercise confidentiality
Demonstrate appropriate human relations skills
Adhere to rules of conduct
Accept constructive criticism
Offer constructive criticism
Take pride in work
Resolve conflict
Manage stress
Avoid sexual connotations and harassment
Adjust to changes in the workplace
Demonstrate punctuality
Assume responsibility for personal decisions and actions
Take responsibility for assignments
Follow chain-of-command

Competency: Apply decision-making techniques

Competency Builders:

Identify decision to be made
Identify ownership of decision to be made
Identify possible alternatives and their consequences
Make decisions based on facts, legality, ethics, goals, and/or culture
Apply time factor(s)
Present decision to be implemented
Evaluate decision made
Take responsibility for decision

Competency: Apply problem-solving techniques

Competency Builders:

Identify problem
Select appropriate problem solving tools/techniques
Identify root problem cause(s)
Track root problem cause(s)
Identify possible solutions and their consequences (e.g., long term, short term, crisis)
Use resources to explore possible solutions to problem
Contrast advantages and disadvantages of each solution
Identify appropriate action
Evaluate results
Identify post-preventive action

Competency: Exhibit characteristics for job advancement

Competency Builders:

Display positive attitude
Demonstrate knowledge of position
Perform quality work
Adapt to changing situations and technology
Demonstrate capability/responsibility for different positions
Identify characteristics of effective leaders
Identify opportunities for leadership in work place/community
Demonstrate initiative to affect change in workplace
Participate in continuing education/training program
Responds appropriately to criticism from employer, supervisor, or other employees
Exhibit awareness of corporate culture
Prepare for job setbacks
Exhibit continual growth based on performance evaluation
Set realistic goals

Unit: Professionalism

Competency: Project professional image

Competency Builders:

Define professionalism
Exhibit professional appearance
Exhibit professional manners
Project professional attitude
Identify individuals' vital role in organization
Exhibit proper etiquette in professionally-related situations

Competency: Achieve individual and professional goals

Competency Builders:

Set flexible, realistic, and measurable goals
Identify potential barriers to achieving goals
Identify strategies for addressing barriers to goal achievement
Breakdown long-term goals into short-term goals
Prioritize goals
Commit to goals
Adjust goals
Obtain support for goals
Reward goal achievement

Competency: Manage personal finances

Competency Builders:

Explain need for personal management records
Balance checkbook
Identify tax obligations
Analyze how credit affects financial security
Compare types and methods of investments
Compare types and methods of borrowing
Compare types and methods of insurance
Compare types of retirement options/plans
Identify discriminatory vs. non-discriminatory expenditures

Competency: Support community well-being

Competency Builders:

Identify environmental, educational, and social issues
Participate in social and/or community activities

Competency: Achieve organizational goals

Competency Builders:

Evaluate personal goals in relation to organizational goals
Monitor progress by evaluating feedback
List responsibilities in relation to organization goals
Accomplish assigned tasks
Exercise responsibility in relation to organizational goals
Set appropriate personal performance standards
Communicate goals with supervisor and peers
Demonstrate knowledge of products and services
Promote organizational image and mission

Competency: Demonstrate positive relations in the workplace

Competency Builders:

Identify personality types of self and other
Identify various management styles
Support employer expectations
Support employer decisions
Accept constructive criticism
Give constructive feedback
Adapt to changes in workplace
List factors to consider before resigning
Write letter of resignation

Competency: Manage stressful situations

Competency Builders:

Accept stress as part of daily life
Identify personal and professional factors contributing to stress
Describe physical and emotional responses to stress
Evaluate positive and negative effects of stress on productivity
Identify strategies for reducing stress
Implement strategies to manage stress
Create strategies for developing and maintaining support systems

Competency: Analyze effects of family on work and work on family

Competency Builders:

Identify how family values, goals, and priorities are reflected in work place
Identify responsibilities and rewards associated with paid and non-paid work
Identify responsibilities and rewards associated with families
Explain how family responsibilities can conflict with work
Explain how work can conflict with family responsibilities
Explain how work-related stress can affect families
Explain how family-related stress can affect work
Identify family support systems and resources
Identify work-related support systems and resources
Communicate with family regarding work

Competency: Apply lifelong learning skills

Competency Builders:

Define lifelong learning
Identify factors that cause need for lifelong learning
Analyze effects of change
Identify reasons why goals change
Describe importance of flexibility and adaptability
Evaluate need for continuing education/training

Competency: Manage professional development

Competency Builders:

Identify career opportunities
Modify career plan
Participate in continuing education/training opportunities
Document continuing education/training
Read profession-related manuals, technical journals, and periodicals
Attend meetings, workshops, seminars, conferences, and demonstrations
Participate in professional organizations
Build personal/professional mentor relationship
Build personal/professional support system
Build professional network
Strengthen communication skills
Strengthen leadership skills
Strengthen management skills

Unit: Teamwork

Competency: Demonstrate knowledge of teamwork

Competency Builders:

Define empowerment
Differentiate work groups and teams
Identify conditions essential to teamwork (e.g., brainstorming)
Explain influence of culture (e.g., corporate, community) on teamwork
Identify appropriate situations for using teams
Define team structures (e.g., cross functional, quality improvement, task force, quality circles)
Identify team building concepts
Describe characteristics and dynamics of teams
Identify characteristics of effective team leaders and members
Identify responsibilities of a valuable team member
Identify methods of involving each member of a team
Explain how individuals from various backgrounds contribute to work-related situations (e.g., technical training, cultural heritage)
Explain the purpose of facilitators
Define consensus
Define reward/recognition system

Competency: Demonstrate teamwork

Competency Builders:

Identify purpose of team and intended goal (include time frames)
Structure team around purpose
Define responsibilities of team members
Contribute to efficiency and success of team
Work toward individual and team milestones
Analyze results of team project
Facilitate a team meeting
Assist team member(s) with problem
Monitor time frame
Stress continuous improvement
Accept failure as part of learning

Competency: Use teamwork to solve problems

Competency Builders:

Identify appropriate situations for using teams
Use problem-solving process in a team setting
Identify quality management processes/techniques
Identify quality assurance processes/techniques
Prepare presentation

Competency: Conduct team meetings

Competency Builders:

Plan agenda
Schedule meeting and location
Invite appropriate personnel
Solicit outside speakers as needed
Assign someone to take minutes
Facilitate introductions
Invite questions and comments and group participation
Focus team on agenda items
Assign appropriate action, time frame and accountability to tasks
Monitor time
Close meeting on time
Publish minutes in timely manner
Set ground rules
Avoid placing individual agendas above the group's agenda

Unit: Quality Assurance

Competency: **Demonstrate knowledge of quality assurance**

Competency Builders:

Explain the historical evolution of quality assurance (e.g., Deming, ISO 9000)
Explain changes brought about by quality leaders in the world
Explain the ISO 9000 process
Define quality terms
Define quality functions
Identify features of quality planning
Describe control devices used in functional areas (e.g., SPC, equipment)
Explain the relationship among organizational structures, policies, procedures, and quality assurance
Explain importance of internal and external customers
Identify internal and external customers
Describe successful efforts by industry to improve quality and/or reduce costs
Differentiate prevention and detection
Differentiate variable and attribute data
Identify types of coontrol charts
Explain how statistical techniques are tools used to control quality (e.g., SPC, DOE, CR)

Competency: **Demonstrate knowledge of quality cost implications**

Competency Builders:

Identify cost/quality objectives
Classify costs (i.e., direct and indirect, fixed and variable, methods and standards)
Classify quality costs (i.e., prevention, evaluation, pre-delivery failure, post-delivery failure)
Define produce liability
Interpret quality cost reports
Explain consumerism and liability prevention
Define safety terms of product
Identify safety responsibility within organization
Define contracts and torts
Differentiate express and implied warranty
Differentiate warranty and product liability
Explain how warranties are part of contract law
List questions that would need answering in liability claim

Competency: **Demonstrate knowledge of engineering a quality product**

Competency Builders:

Associate customer satisfaction with product characteristics (e.g., usefulness, price, operation, life, reliability, safety, cost of operation)
Define manufacturability
Identify steps in product design (e.g., brainstorming, thumbnail sketches, rendering)
Define reliability factors (e.g., cost, human, producibility)
Identify ways reliability is achieved (e.g., maintainability, good design, design simplification, design redundancy)
Explain the relationship of maintainability to reliability
Define failure
Explain the role of testing and reliability
Define value engineering
Define quality objectives
Identify cost components as they relate to quality objectives
Classify quality costs (i.e. preventive, evaluation, pre-delivery failures, post delivery failures)
Describe predictive maintenance

Competency: **Explain importance of interdepartmental relationships to quality assurance**

Competency Builders:

Explain need for everyone's commitment in assuring quality
Explain phrase "Everyone is a customer/supplier"
Define quality improvement team models
Explain the importance of top management's support of quality
Explain project selection
Explain project implementation
Explain project evaluation
Explain continuing improvement
Describe future trend of experiment design
Describe future trend of predictive maintenance

Competency: **Manipulate quality cost data**

Competency Builders:

Develop quality cost data
Translate cost reports
Graph quality cost data (e.g., pareto)

Competency: **Manipulate cost control data**

Competency Builders:

Develop cost control data
Analyze cost control reports
Provide cost control data
Provide advice on "Make or Buy" decisions (including economical lot size decisions)

Competency: Demonstrate knowledge of basic statistics

Competency Builders:

Describe data collection methods
Collect data
Organize data by flow chart
Interpret data by cause and effect diagrams
Define nominal, ordinal, interval, and ratio data
Define mean, median, and mode
Explain significance of standard deviation
Explain normal distribution

Competency: Demonstrate knowledge of scattergrams

Competency Builders:

Construct scattergram
Interpret for positive, negative, or no correlation between X and Y variables
Test for significance between one and five percent
Explain regression analysis

Competency: Demonstrate knowledge of probability theory

Competency Builders:

Define classical probability
Define empirical probability
Calculate probability for outcomes

Competency: Demonstrate knowledge of precontrol

Competency Builders:

Explain uses of precontrol
Calculate precontrol limits
Explain significance of the limits
Plot values on a precontrol chart
Explain "out-of-control" situation
Make decisions on green, yellow and red conditions

Competency: Demonstrate knowledge of process capability

Competency Builders:

Use X, R, USL, and LSL to determine process capability (upper and lower specification limits)
Calculate estimated process standard deviation
Plot right hand and left hand tail of process variation
Compute Z value for percent of probable defect for process
Calculate C_{PK} values that describe process capability
Describe skewed distributions
List probable causes of skewed distribution

Competency: Use quality control charts

Competency Builders:

Identify operational definitions for attribute criteria
Interpret histogram
Interpret scattergrams
Interpret NP chart
Interpret P chart
Interpret flowchart
Interpret cause-and-effect diagram
Construct P (percentage defective) chart for attributes
Plot control limits of P chart and data points
Check chart for out-of-control conditions
Construct an NP (number defective) chart with control limits and data
Construct C (count of defects) and U (number of defects per unit) charts
Check data on C and U charts
Construct flowchart
Construct cause-and-effect chart

Competency: Interpret $\bar{X}$ and R charts

Competency Builders:

Plot percentages for normal distribution
Test distribution for normality
Explain difference between common cause and special cause
Define an "in-control" process
Explain significance of an out-of-control point on $\bar{X}$ or R chart
Identify patterns and trends on control chart
Identify run up and run down
Test for middle third on control chart
Explain significance of middle third on control chart
Explain Rule of Sevens

Competency: Construct $\bar{X}$ and R charts

Competency Builders:

Arrange data into statistical sub-groups
Explain importance of random sampling
Compute $\bar{X}$ (i.e., average of values) and R (i.e., range of values in subgroup) within sample
Plot in $\bar{X}$ and R on chart
Construct control chart with $\bar{\bar{X}}$ (grand average) and R (average range) calculated
Calculate upper and lower control limits for $\bar{X}$-chart
Calculate upper and lower control limits for R-chart

Competency: Conduct process improvement studies

Competency Builders:

Analyze production methods and processes applying statistical process improvement techniques (e.g., SPC, C_{PK})
Identify appropriate statistical techniques for study (e.g., T-tests, F-test, capability, DOEX)
Identify major steps in conducting a study
Define "report" for a study (e.g., goal, objective, study conduct, results, conclusions, discussions)
Integrate results into the total system

Competency: Demonstrate knowledge of JIT

Competency Builders:

Define just-in-time concept (JIT)
Describe various production methodologies (e.g., standard cycle times, routings, standard quantities, multiple-machine tending)
Describe types of inventory control (e.g., Kanban)
Describe importance of flexibility
Differentiate product layout, process layout, fixed position layout, and cellular layout
Differentiate straight-line, U-shaped, S-shaped, convoluted and comb patterns
Describe advantages/disadvantages of layout and patterns
Explain importance of product protection, identification and storage
List methods of identifying products (e.g., labels, bar codes, radio frequency systems and magnetic strip systems)
Describe manual methods of storage and retrieval
Describe automated storage and retrieval systems (ASRS)
Describe automated guided vehicle moving systems (AGVS)

Competency: Apply JIT

Comptency Builders:

Maintain system for physical handling and movement of material in-process and in-storage
Monitor system of physical handling and movement of material in-process and in-storage
Maintain system for physical handling and movement of finished products
Monitor system of physical handling and movement of finished products
Write requests for deviation from specifications
Implement quality control and inspection standards and procedures
Write engineering change notices and rejection reports
Monitor reports of discrepancy or rejects during production process
Conduct quality tests under different environmental conditions

Competency: Demonstrate knowledge of inspection

Competency Builders:

Explain purpose of inspection
Describe scope of inspection
Explain purpose of incoming, ongoing, and final inspections
Explain early detection inspection
Explain how statistical process control (SPC) aids inspection
Define types of nonconformance
Define degrees of nonconformance
Define corrective action
Describe when to 100% inspect
Describe when to sample inspect
Describe methods of testing for material properties (e.g., harness, strength, chemical makeup, flaws, errors in tooling or setup)
Define rework, salvage, and scrap
Describe ethical decisions an inspector may make
Identify purposes of computer-automated inspection
Explain advantages and limitations of automated inspection
Explain disposition of non-conforming material
Explain basic foolproofing concept to build inspection into process (i.e., poka-yoke)
Use checksheets to organize and record inspection results

Competency: Inspect machinery, materials, and products

Competency Builders:

Identify critical material characteristics from specification(s) or drawing(s)
Perform capability studies for machinery and materials acceptance
Identify appropriate acceptance sampling plan
Conduct incoming materials inspection using sampling plan criteria
Identify critical in-process characteristics from specification(s) or drawing(s)
Demonstrate basic metrology skills
Conduct in-process inspection
Identify appropriate inspection reports and follow-up
Gauge R and R (reproducibility and repeatability)
Apply geometric tolerancing
Explain C = O (zero) acceptance plan
Interpret instructions in a control plan

Competency: **Demonstrate knowledge of nondestructive testing**

Competency Builders:

Describe purpose of nondestructive testing
Identify anomalies
Define defects and discontinuities
Identify factors contributing to defects and discontinuities
Describe ultrasonic testing
Describe advantages and limitations of ultrasonic testing
Describe industrial radiography
Compare use of wet and dry particles in magnetic particle inspection
Explain advantages and limitations of penetrant inspection
Describe microwave testing
Describe holographic inspection
Explain choice of most suitable nondestructive test method
Describe eddy-current testing

Unit: Technical Recording and Reporting

Competency: Demonstrate proficiency in technical recording

Competency Builders:

Describe various documentation procedures
Interpret specifications or drawings
Observe process
Ask open-ended questions
Record process (e.g., flowchart, step-by-step)
Identify parameters
Record accurate, truthful data
Maintain test logs
Compile cumulative reference notebook/record
Measure appropriate parameters
Draft preventive maintenance and calibration procedures

Competency: Demonstrate proficiency in technical reporting

Competency Builders:

Use data books and cross reference/technical manuals
Compose technical memoranda
Identify type of report or format needed
Use appropriate format
Compile relevant data
Design charts and graphs
Analyze data
Draw conclusions
Explain analytical methods used
Outline reports
Write reports
Present reports

Unit: Computer Literacy

Competency: Describe personal computer operations

Competency Builders:

Explain how data is stored in main computer memory
Explain how computer system executes program instruction
Explain computer storage capacity
Explain how data is represented
Describe data storage techniques
Identify types of memory

Competency: Explain information processing cycle

Competency Builders:

Define operating systems (e.g., DOS, OS/2, UNIX, MAC)
Describe computer languages and their use
Describe computer languages and their use
Describe computer languages and their use
Describe difference between data files and program files
Explain PC layout
Explain PC network layout
Explain mini/mainframe network layout
Differentiate hardware and software
Differentiate open from proprietary architecture

Competency: Operate computer hardware

Competency Builders:

Practice proper media handling techniques (e.g., magnetic fields, dust, liquids)
Identify hardware and its use
Use hardware (e.g., mouse, diskettes, drive, modems, touch screen, printers, digitizers, scanners, cables, protection devices)
Keyboard efficiently
Demonstrate basic care of hardware
Explain need for and application of security levels/procedures
Perform basic hardware troubleshooting
Explain hardware addressing techniques

Competency: Use software

Competency Builders:

Define software types and functions
Describe basic disk operations and care
Perform functions necessary to operate software
List advantages and disadvantages of integrated and dedicated software
Operate system software
Operate diagnostic software
Demonstrate basic proficiency in spreadsheet use
Demonstrate basic proficiency in word processing
Demonstrate basic proficiency in database use
Demonstrate basic proficiency in network use
Demonstrate basic proficiency of utility (e.g., WINDOWS, GUI)
Demonstrate basic proficiency in report writing
Demonstrate system commands
Differentiate ethical use/misuse of software
Describe bulletin boards/electronic mail
Apply security levels/procedures while handling sensitive data
Explain data compression techniques
Explain use and deletion of passwords

Unit: Workplace Safety

Competency: Apply general safety precautions

Competency Builders:

Identify local, state, and federal rules and regulations
Identify personal protective wear and equipment
Identify visual controls (e.g., monitors, read outs)
Identify auditory controls
Identify common sense housekeeping
Interpret hazardous materials notices on containers
Use personal protective wear and equipment
Apply workplace safety rules and procedures
Apply personal safety rules and procedures
Apply workplace organization (e.g., housekeeping)
Apply applicable electrical, mechanical, steam, hydraulic and (e.g., pneumatic safety rules and procedures)
Apply fire safety rules and procedures
Apply hazardous wastes rules and procedures
Apply first aid
Locate (MSDS)
Perform lockout and tagout
Recycle scrap metal, chips, shavings, coolants, solvents, trash, and waste materials
Apply common sense housekeeping
Use preventive maintenance checklists

Competency: **Demonstrate knowledge of safety and workplace hazards**

Competency Builders:

Describe corrective procedures for unsafe conditions
Identify types and potential level of workplace hazards (e.g., physical hazards, fire, chemicals, noise, ionizing radiation, ultraviolet, temperature extremes, ergonomics, biological hazards)
Identify safety materials/equipment (e.g., absorbant socks, oil dry)
Interpret Material Safety Data Sheets (MSDS)
Explain purpose(s) of OSHA and NIOSH
Explain purpose(s) of NEC and NFPA
Identify purpose of emergency evacuation routes, master switch and lockout locations, and safety color coding systems
Identify roles of industrial hygienists, safety professionals, occupational physicians, and occupational nurses
Describe methods of evaluating potential hazards (e.g., visual analysis)
Describe methods of correcting potential hazards
Describe various types of toxicity (e.g., chronic, immediate)
Identify need for reporting accidents
Explain precautions required when using toxic or flammable materials
Define confined space and related requirements
Explain how international directives relate to safety

Competency: **Explain purpose of industrial pollution control systems**

Competency Builders:

Describe types of air, water, solid waste, and noise pollution
Explain purpose of air pollution control systems
Explain purpose of water pollution control systems
Explain purpose of solid waste pollution control systems
Explain purpose of noise pollution control systems
Explain basic philosophy of "right to know" legislation
Explain purpose(s) of EPA
Identify "costs" of industrial pollution control (i.e., dollars vs. impact to environment)
Describe ethics of environmental issues

Competency: Demonstrate knowledge of ergonomics

Competency Builders:

Define ergonomics
Define risk factor
Define maximum permissible limit (MPL) and action limit (AL) for lifting
Define cumulative trauma disorder (CTD)
Identify susceptibility factors for CTD
Minimize extreme joint movement
Minimize use of excessive muscle force
Minimize repetitive tasks
Minimize mechanical stresses (e.g., sharp edges, heat, cold, hard surfaces, weights, vibration)
Minimize awkward body positions
Explain use of rest pauses
Explain need for mats and footrest for standing jobs
Explain need for appropriate working heights of chairs, stools, workbenches, equipment
Explain need for adequate lighting
Explain use of anthropometric (i.e., centering one's view of everything around man) design

Unit: Supervision

Competency: Perform supervisory functions

Competency Builders:

Define supervision
Conduct task analysis
Create organizational and/or departmental charts
Apply company policies and procedures
Maintain workplace procedures manuals
Prepare budgets
Monitor budgets
Prepare managerial reports
Analyze daily production reports
Maintain appropriate work environment
Conduct tours
Facilitate assignments
Assign work
Delegate job tasks
Monitor progress
Prepare productivity reports
Provide training for new policies
Troubleshoot workplace problems
Coordinate workplace activities
Appraise performance
Document personnel issues
Coordinate administrative duties

Competency: Coordinate training

Competency Builders:

Assess training needs
Secure training resources, materials and equipment
Train employees
Evaluate progress of trainee
Provide feedback
Solicit feedback
Receive feedback
Assess feedback

Unit: Basic Electronics

Competency: Demonstrate proficiency in electronics fundamentals

Competency Builders:

Identify electronic components and schematic symbols
Describe basic atomic structure and its relationship to electricity
Describe the relationship between electrical and magnetic properties
Describe the electrical and magnetic properties of a magnet
Describe the photoelectric effect
Describe the thermocouple effect
Describe the electrical effect of friction
Use metric units to solve electronic unit problems
Identify sources of electricity
Describe principles and operations of electrochemical supplies
Describe voltage, current, resistance, power, and energy
Apply Ohm's Law
Apply Kirchoff's Laws
Apply power formulas
Explain Thevenin's Theorem
Explain Norton's Theorem
Interpret color codes and symbols to identify electrical components and values
Measure properties of circuits using test equipment
Describe electrostatic discharge (ESD) procedures

Competency: Demonstrate proficiency in DC circuits

Competency Builders:

Compute conductance of conductors and insulators
Measure resistance and current of conductors and insulators
Measure properties of a circuit using volt-ohm meter (VOM) and digital volt-ohm meter (DVM)
Build series, parallel, and combination circuits
Build bridge circuits
Build voltage divider circuits (loaded and unloaded)
Compute voltage divider circuits (loaded and unloaded)
Demonstrate maximum power transfer theory
Describe magnetic properties of circuits and devices
Explain physical and electrical characteristics of capacitors and inductors
Describe RC and RL time constants
Compute RC and RL time constants
Demonstrate use of diodes in DC circuits
Identify need for rectification
Operate power supplies for DC circuits
Analyze frequency spectrums
Construct the operation of DC circuits that demonstrate maximum power transfer theory
Use meters and oscilloscopes
Measure current, voltage, and resistance in DC circuits
Explain simple DC generator action
Explain simple DC motor action
Explain principals of solid-state switching devices
Solve algebraic problems to include exponential (prerequisite to DC) (algebraic calculation)
Explain use of DC in relation to communications
Identify classes, voltage ratings and/or polarity of electronic components
Identify use of circuit protective devices (e.g., fuses, breakers)
Troubleshoot DC circuits

Competency: **Demonstrate proficiency in AC circuits**

Competency Builders:

Analyze properties of an AC signal
Describe principles and operation of characteristics of sinusoidal and non-sinusoidal wave forms
Identify AC sources
Describe principles and operation of characteristics of capacitive circuits
Operate capacitive circuits
Describe principles and operation of characteristics of inductive circuits
Operate inductive circuits
Describe principles and operation of transformers
Demonstrate operation of AC circuits utilizing transformers
Use maximum power transfer theorems
Use Thevenin's and Norton's theorem to analyze AC circuits
Measure power in AC circuits
Operate capacitor and inductor analyzers for AC circuits
Operate differentiators and integrators to determine RC and RL time constants
Describe principles and operation of characteristics of series and parallel resonant circuits
Build series and parallel resonant circuits
Identify classes, voltage, ratings and/or polarity of electronic components
Identify use of circuit protective devices (e.g., fuses, breakers)
Describe principles and operation of characteristics of frequency selective filter circuits
Calculate logarithmic to obtain gain (dB) using tables or calculator/computer
Operate frequency selective filter circuits
Operate polyphase circuits
Describe basic motor theory and operation
Describe basic generator theory and operation
Operate power supplies for AC circuits
Describe principles and operation of various power conditioning (e.g., isolation transformers, surge suppressors, uninterruptable power systems)
Describe principles and operation of various safety grounding systems (e.g., lightning arresters, ground electrostatic discharge, fault interrupters, etc.)
Describe characteristics of inductors in series and parallel circuits
Describe characteristics of capacitance in series and parallel circuits
Compare resistive-capacitive (RC) and resistive-inductive (RL) time constants (TC)
Measure voltage, current, time, frequency (f), and phase relationships of AC sine wave signal
Describe frequency (F) and phase relationships

Competency: **Demonstrate proficiency in AC circuits**

Competency Builders:

Describe resonance of inductive-capacitive (LC) circuits
Calculate impedance match and maximum transfer of power
Measure current, voltage, and resistance in AC circuits
Identify 50/60 Hertz
Explain simple AC generator action
Explain simple AC motor action
Calculate power factor in AC circuits
Explain harmonics and its effects on power quality
Solve basic trigonometric problems as applicable to electronics
Calculate peak (PK), root mean square (RMS), and average values
Troubleshoot AC circuits

Unit: Microcomputer Electronics Technology

Competency: **Demonstrate basic proficiency in microprocessor systems**

Competency Builders:

Describe essential components of microprocessor and their functions
Describe principles and operation of BUS concepts (e.g., VESA, EISA)
Describe principles and operation of types of memory circuits
Identify operating systems (e.g., DOS, OS/2, UNIX)
Describe microprocessor instructions sets
Describe principles and operation of microprocessor machine code
Demonstrate use of microprocessor machine code
Decode microprocessor machine code
Identify types of input and output devices and peripherals
Describe principles and operation of storage devices
Operate oscilloscopes and logic/data analyzers
Interface input and output ports to peripherals
Demonstrate ability to interface peripherals
Identify central processing unit building blocks and their uses
Identify the levels of computer languages

Competency: **Demonstrate basic proficiency in computer systems architecture**

Competency Builders:

Describe the principles and operation of computer system architecture
Operate computer system architecture
Repair computer system architecture
Describe the principles and operation of addresses and interrupts
Describe the principles and operation of volatile and non-volatile memory
Demonstrate the use of volatile and non-volatile memory
Repair or replace volatile and non-volatile memory
Describe the principles and operation of advanced memory techniques
Define individual system blocks
Draw systems configuration in block detail
Interpret computer acronyms
Describe priorities and interrupts at systems level
Identify direct memory access data handling system(s)
Define functions of advanced memory techniques (e.g., virtual, pipeline, cache)
Troubleshoot a microcomputer system

Competency: **Demonstrate proficiency in software fundamentals**

Competency Builders:

Load operating system software
Run operating system software
Load diagnostic software
Run diagnostic software
Construct flow charts
Analyze flow charts
Explain computer languages and their uses
Write a simple computer program
Write program documentation
Describe firmware applications
Identify the need for backup
Describe security measures
Describe virus protection

Competency: Describe elements of communication interfacing

Competency Builders:

Define common EIA, IEEE, and CCITT communication standards (e.g., EIA 232 and 485; IEEE 488)
Identify sync devices
Identify async devices
Identify types of network (e.g., token ring, ethernet)
Identify networking levels or layers
Identify protocols
Identify packet switching
Identify multiuser systems
Operate network analyze devices
Identify network analyzer devices (e.g., breakout bos, sniffers)

Competency: Describe peripheral equipment interfaces

Competency Builders:

Identify types of card and paper-tape equipment and interface controllers
Define printer types and interface controllers
Explain the operation of typical magnetic tape equipment and interface controllers
Identify disk equipment and interface controllers
Define environmental requirements for peripherals and media

Unit: Industrial Electricity

Competency: Explain basic industrial electricity theory

Competency Builders:

Describe atomic structure and its relationship to electricity
Describe the relationship between electrical and magnetic properties
Describe the electrical and magnetic properties of a magnet
Describe the photoelectric effect
Describe the thermocouple effect
Describe the electrical effect of friction
Identify sources of electricity
Identify potential sources of electricity
Describe differences between AC/DC
Describe effects varying degrees of electricity have on the human body

Competency: Use the National Electrical Code (NEC)

Competency Builders:

Use NEC to identify correct materials
Use NEC to identify correct methods
Use NEC to identify correct applications
Use NEC to identify correct safety procedures

Competency: Explain operation of electrical distribution systems

Competency Builders:

Follow NFPA, local, state, and national codes
Describe functions of permits and licensing requirements
Explain generation of electricity
Explain transmission of electricity
Explain end user distribution

Competency: **Maintain basic electrical systems**

Competency Builders:

Replace electrical cords
Replace batteries
Replace fuse(s)
Replace switches and other sensors
Replace plugs and sockets
Replace control panel components (e.g., relays, motor starters)
Replace AC motors (e.g., 3 phase, single phase)
Replace DC motors

Competency: **Interpret electrical/electronic drawings**

Competency Builders:

Interpret basic electric/electronic standards and symbols (e.g., NEC, IEC)
Interpret schematic drawings
Interpret cable drawings
Interpret component drawings
Interpret logic diagrams
Interpret control panel drawings
Interpret connection drawings
Interpret interconnection drawings
Interpret printed circuit board drawings
Interpret harness drawings
Interpret package drawings
Interpret mechanical/electronic production blueprints and assembly drawings

Competency: **Demonstrate proficiency in direct current (DC) circuits**

Competency Builders:

Describe voltage, current, resistance, power, and energy
Solve algebraic problems to include exponential (prerequisite to DC)
Measure properties of a circuit using volt-ohm meter (VOM) and digital volt-ohm meter (DVM) meters and oscilloscopes
Apply Ohm's Law
Construct parallel circuits
Construct series circuits
Construct series parallel and bridge circuits
Define voltage divider circuits (loaded and unloaded)
Construct DC circuits that demonstrate the maximum power transfer theory
Solve problems in electrical units utilizing metric units
Describe the principles and operation of electrochemical supplies
Apply Kirchoff's law
Interpret color codes and symbols to identify electrical components and values
Measure properties of a circuit using analog and digital meters and oscilloscopes
Measure conductance and resistance of conductors and insulators
Describe magnetic properties of circuits and devices
Describe the physical and electrical characteristics of capacitors and inductors
Describe RC and RL time constants
Set up power supplies for DC circuits
Operate power supplies for DC circuits
Analyze frequency spectrums
Apply Thevenin's and Norton's theorems

Competency: **Demonstrate proficiency in alternating current (AC) circuits**

Competency Builders:

Solve basic trigonometric problems as applicable to electricity (prerequisite to AC)
Analyze AC signals utilizing VOM, DVM, oscilloscope, frequency counter and function generator
Analyze power in AC circuits
Measure power in AC circuits
Operate capacitor and inductor analyzers for AC circuits
Analyze properties of an AC signal
Describe the principles and operation of the characteristics of sinusoidal and non-sinusoidal wave forms
Identify AC sources
Describe the principles and operation of the characteristics of capacitive circuits
Demonstrate the operation of capacitive circuits
Describe the principles and operation of the characteristics of inductive circuits
Demonstrate the operation of inductive circuits
Describe the principles and operation of the principles of transformers
Demonstrate the operation of AC circuits utilizing transformers
Operate differentiators and integrators to determine RC and RL time constants
Describe the principles and operation of the characteristics of RLC circuits (series, parallel, and complex)
Demonstrate the operation of RLC circuits (series, parallel, and complex)
Describe the principles and operation of the characteristics of series and parallel resonant circuits
Operate series and parallel resonant circuits
Describe the principles and operation of the characteristics of frequency selective filter circuits
Demonstrate the operation of frequency selective filter circuits
Operate polyphase circuits
Describe basic motor theory and operation
Describe basic generator theory and operation
Operate power supplies for AC circuits
Describe the principles and operation of various power conditioning (e.g., isolation transformers, surge suppressors, uninterruptable power systems)
Describe the principles and operation of various safety grounding systems (e.g., lightning arresters, ground fault interrupters, etc.)
Apply maximum power transfer theorems
Apply Thevenin's and Norton's theorems to analyze AC networks

Unit: Computer Hardware Design

Competency: **Demonstrate proficiency in solid-state devices**

Competency Builders:

Define properties of semiconductor materials
Define operating characteristics and applications of junction diodes
Define operating characteristics and application of special diodes
Construct diode circuits
Troubleshoot diode circuits
Define operating characteristics and applications of transistors
Define operating characteristics and applications of single-stage amplifiers
Construct single-stage amplifiers
Construct transistor circuitry
Troubleshoot transistor circuitry

Competency: **Demonstrate proficiency in integrated circuits**

Competency Builders:

Define characteristics of various groups of ICs
Identify properties of the most common types of ICs in each group
Construct logic circuits using ICs
Troubleshoot logic circuits

Competency: **Operate test equipment**

Competency Builders:

Operate a DVM for solid-state devices
Operate power supplies for solid-state devices
Operate oscilloscopes for solid-state devices
Operate function generators for solid-state devices
Operate transistor testers

Competency: **Demonstrate proficiency in computer systems architecture**

Competency Builders:

Define computer acronyms
Define priorities and interrupts at system level
Define functions of advanced memory techniques (virtual, pipeline, cache)
Identify direct memory access data handling systems
Explain systems configurations in block detail
Draw systems configurations in block detail
Troubleshoot a microcomputer system

Competency: **Demonstrate proficiency in software fundamentals**

Competency Builders:

Load operating system software
Run operating software
Load diagnostic system software
Run diagnostic system software
Write a computer program
Analyze firmware concepts

Competency: **Demonstrate knowledge of communication interfacing**

Competency Builders:

Define industry standards (e.g., EIA, IEEE, CCITT)
Define networking levels or layers
Define protocols
Define packet switching
Define multiuser systems
Define sync devices
Analyze sync devices
Define async devices
Analyze async devices

Competency: Troubleshoot peripheral equipment

Competency Builders:

Define environmental requirements for peripherals and media
Describe the operation of typical magnetic tape equipment and interface controllers
Analyze disk equipment and interface controllers
Align disk equipment and interface controllers
Troubleshoot a mouse
Troubleshoot bar code scanner
Troubleshoot printers and interface controllers (including laser printers)
Troubleshoot display terminals and interface controllers, (including touch screens)

Competency: Demonstrate knowledge of operating systems

Competency Builders:

Identify operating systems and their attributes
Describe how commands handle tasks in operating systems
Describe various input/output systems
Describe the purpose of operating system utilities
Explain the difference between a compiler and an interpreter
Describe the processing that occurs when an interpreter is used
Describe the processing that occurs when a compiler is used

Unit: Local Area Network (LAN) Operations

Competency: Explain LAN operations

Competency Builders:

Define local area network
Define different types of LANs
Differentiate network operating systems from data distribution systems
Identify advantages and disadvantages of various LAN operating systems
List duties of LAN supervisor
Define security levels

Competency: Apply LAN operations

Competency Builders:

Assess user needs to determine which LAN operating systems to use
Configure system
Change hardware as needed
Install application software
Demonstrate applications used on LANs
Operate the system in a multi-user environment
Describe various networks and their compatibility
Differentiate among various topologies

Competency: **Maintain LAN**

Competency Builders:

Use appropriate reference materials
Respond to system messages
Troubleshoot system
Run diagnostic software
Back up system(s)
Restore system(s)
Perform system analysis
Use security procedures
Perform preventive maintenance
Explain how LAN software is installed
Explain how network protocols work together

TECH PREP

"GET SERIOUS . . . ABOUT SUCCESS"

Computer Programming Technician

Units to Consider: **Page**
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—NOTICE—

Each Tech-Prep Competency Profile developed should respond to the labor market demands of your Tech Prep Consortium. Therefore, the following pages should be examined carefully before being selected for use in TCP Part I. **[See "The TCP Process" for more information.]** For example, in some cases the number of units far exceeds the amount of content that can be covered within a 4 + 2 TPAD Program. All the units listed in this section will not necessarily apply to your situation, nor will all the competencies within each unit be appropriate. Note that several units appear within each specific occupation and would need to only appear once if you are compiling a cluster of occupations. **[See "TCP Matrix" and "How to Use the TCP Binder" for more information.]**

Unit: Communications Literacy

NOTE: This content was extracted from the 9-12 cluster of Ohio's Model Language Arts Program. Due to statewide initiatives other than Tech Prep, this literacy unit was not altered to meet competency-based criteria. Each literacy unit forms a critical link between academic teachers and members of business, industry, and labor. [See "The TCP Process" for more information.]

Subunit: Reading—Structure
Competencies:

RS1 Exhibit knowledge of language structure
RS2 Recognize that there may be more than one interpretation of reading selections
RS3 Recognize various literary devices
RS4 Recognize and discuss literary elements
RS5 Develop and use an increasingly sophisticated vocabulary gained through context
RS6 Apply knowledge of language structure to reading
RS7 Explain why there may be more than one interpretation of reading selections
RS8 Recognize effect of literacy devices on meaning
RS9 Analyze author's use of literary elements
RS10 Recognize relationship of structure to meaning
RS11 Describe various interpretations and meaning levels in reading selections
RS12 Characterize author's use of literary devices
RS13 Characterize use of literary techniques
RS14 Critique a variety of literature with regard to plot, dialogue, theme, setting, and characterization
RS15 Apply an expanding vocabulary gained through reading
RS16 Explain various interpretations and meaning levels in reading selections
RS17 Analyze use of literary techniques (e.g., extended metaphor, simile, personification, hyperbole, pun, alliteration)
RS18 Understand use of literary devices (e.g., irony, satire, allegory, onomatopoeia)
RS19 Analyze and synthesize pieces of literature with regard to plot, dialogue, theme, setting, and characterization

Subunit: Reading—Meaning Construction
Competencies:

RM1	Demonstrate ability to recognize appropriate pre-reading strategies
RM2	Describe effectiveness of a reading selection
RM3	Read to clarify personal thinking and knowledge
RM4	Support interpretation of text by locating and citing specific information
RM5	Develop personal response to a variety of literary works
RM6	Recognize diverse literary interpretations
RM7	Engage in self-selected reading activities
RM8	Confirm and extend meaning in reading by researching new concepts and facts
RM9	Self-monitor and apply corrective strategies when communication has been interrupted or lost
RM10	Use features of literary genres to extend meaning
RM11	Assess effectiveness of a selection read
RM12	Use reading as a possible problem-solving strategy to clarify personal thinking and knowledge
RM13	Use knowledge of semantic elements (e.g., figurative language, denotation, connotation, dialect) to clarify meaning when reading
RM14	Predict, recognize, interpret, and analyze themes based on familiarity with author's work
RM15	Compare and contrast literary genres
RM16	Assess validity and quality of selection read
RM17	Clarify meaning when reading
RM18	Compare personal reaction to critical assessment of a literary selection
RM19	Assess validity of diverse literary interpretations
RM20	Use reference books to find, evaluate, and synthesize information
RM21	Identify tone of a literary work
RM22	Critique validity of diverse literary interpretations
RM23	Integrate personal reaction to and critical assessment of a literary selection

Subunit: Reading—Application

Competencies:

RA1	Select and read material for personal enjoyment and information
RA2	Read a variety of complete, unabridged works
RA3	Employ various reading strategies according to purpose
RA4	Participate in selection of books, materials, and topics for literature study groups
RA5	Develop and apply knowledge of the interrelationship of concepts
RA6	Read selections from a variety of styles and formats, recognizing that style and format influence meaning
RA7	Extend value of reading, writing, speaking, viewing, and listening by pursuing, through reading, new concepts and interests developed as a result of these activities
RA8	Read extensively from a particular author's work and explain elements
of	author's style

Subunit: Reading—Multidisciplinary

Competencies:

RM1	Connect themes and ideas across disciplines through literature
RM2	Read to facilitate learning across curriculum
RM3	Read to develop awareness of human rights and freedom
RM4	Participate actively in a community of learners
RM5	Recognize and explain interaction between literature and various cultural domains (e.g., social technological, political, economic)
RM6	Explore and analyze a variety of cultural elements, attitudes, beliefs, and value structures by men and women of many racial, ethnic, and cultural groups
RM7	Value thinking and language of others
RM8	Relate literature to historical period about which or in which it was written
RM9	Read to facilitate content learning

Subunit: Writing—Structure
Competencies:

WS1	Develop and expand a repertoire of organizational strategies (e.g., narration, comparison/contrast, and description) through a practice and discussion
WS2	Clarify word choice according to audience, topic, and purpose
WS3	Locate and correct errors in usage, spelling, and mechanics using a variety of resources
WS4	Recognize information gained from primary and secondary sources
WS5	Develop writing which contains ordered, related, well-developed paragraphs with sentences of varied lengths and patterns
WS6	Use information from a variety of sources to develop an integrated piece of writing
WS7	Evaluate and revise writing to focus on such things as audience, tone, and purpose
WS8	Recognize differences between documentation and reference list styles
WS9	Develop extended pieces of writing which contain ordered, related, well-developed paragraphs with sentences of varied lengths and patterns
WS10	Select from a repertoire of organization strategies a pattern appropriate to a topic
WS11	Synthesize information from a variety of sources
WS12	Refine word choice and tone according to audience, situation, and purpose
WS13	Appropriately cite information gained from primary and secondary sources
WS14	Use style manuals or software to prepare documentation and reference lists
WS15	Develop effectively organized pieces of expository writing containing strong voice, clear thesis, and well-developed ideas
WS16	Identify organization patterns appropriate to writing topic
WS17	Respond to others' suggested revisions to a writing piece

Subunit: Writing—Meaning Construction

Competencies:

WM1	Demonstrate knowledge of the recursive nature of the writing process by applying it appropriately to various topics, situations, and audiences
WM2	Develop criteria for writing evaluation using scoring guides and peer/teacher assistance to clarify meaning
WM3	Respond to others' suggested revisions to a piece of writing
WM4	Use word processing, graphics, and publishing aids to construct meaning in writing
WM5	Engage in self-initiated writing activities
WM6	Incorporate personal criteria with generally accepted standards for writing evaluation
WM7	Evaluate, analyze, and synthesize information for writing
WM8	Evaluate own writing using personal and established scoring criteria
WM9	Assess personal/peer revisions to a writing piece
WM10	Recognize and refine personal writing styles

Subunit: Writing—Application
Competencies:

WA1 Apply appropriate writing techniques suitable for varied writing tasks
WA2 Use sentence-combining techniques to improve syntactic fluency and maturity
WA3 Write in response to prompted and self-selected topics in practical, persuasive, descriptive, narrative, and expository domains
WA4 Develop personal voice in writing
WA5 Consider audience and purpose for writing
WA6 Develop criteria for selection and potential development of topic
WA7 Write in a journal or learning log to clarify personal thinking and knowledge
WA8 Apply an expanding vocabulary gained through writing
WA9 Make judicious use of reference sources (e.g., dictionary, thesaurus, on-lien data base, encyclopedia)
WA10 Demonstrate, an appreciation for aesthetically pleasing language through word choice and style
WA11 Apply revising and editing strategies needed for writing task
WA12 Vary sentence lengths and patterns
WA13 Refine personal voice in writing
WA14 Vary styles and formats for intended purpose and audience
WA15 Apply criteria for selection and development of topic
WA16 Participate in peer review of writing in progress
WA17 Use transitions between sentences, ideas, and paragraphs in writing
WA18 Revise and edit papers extensively in preparation for presentation/publication
WA19 Develop a variety of genres
WA20 Focus writing and tone on such elements as audience, situation, and purpose
WA21 Develop topic fully and appropriately
WA22 Use writing process to clarify personal thinking and knowledge
WA23 Apply appropriate recursive writing process as suggested by writing task and writer's process
WA24 Develop an extended piece of writing
WA25 Revise writing and tone to assure focus on such elements as audience, situation, and purpose
WA26 Use writing process to write reflectively

Subunit: Writing—Multidisciplinary

Competencies:

WM1	Use writing process for learning across curriculum
WM2	Use writing process to demonstrate knowledge of need for human rights and freedom
WM3	Value and apply collaborative skills in writing process
WM4	Write in response to reading, speaking, viewing, and listening
WM5	Use multidisciplinary resources in writing projects
WM6	Use writing process to facilitate learning across curriculum
WM7	Recognize value of and engage in collaboration in writing process
WM8	Use communication processes to develop a published writing piece in collaboration with others
WM9	Record experiences and observations related to content learning
WM10	Apply collaborative skills in writing process
WM11	Write collaboratively with peers
WM12	Use cross-disciplinary resources in writing projects

Subunit: Listening/Visual Literacy—Structure

Competencies:

LS1	Listen to and view a wide variety of genres
LS2	Become aware of an author's style through listening and viewing a variety of works
LS3	Recognize correct and appropriate grammar, diction, and syntax
LS4	Expand vocabulary through listening to and viewing varied media
LS5	Recognize beauty of language
LS6	Enhance recognition of an author's style through listening and viewing a variety of works
LS7	Recognize use and misuse of language in media
LS8	Refine knowledge of style through listening and viewing multiple works by the same author
LS9	Expand and refine grammar, diction, and syntax through listening
LS10	Compare authors' styles through viewing and listening to their works
LS11	Expand knowledge of complex grammar, diction, and syntax issues

Subunit: Listening/Visual Literacy—Meaning Construction
Competencies:

LM1 Develop critical thinking skills necessary to evaluate media and assess oral presentations
LM2 Compare new oral texts to past experiences and knowledge in order to enhance comprehension
LM3 Recognize how rhythmic patterns, silence, and cadences enhance quality of speech and literature
LM4 Focus listening and viewing on themes and/or plots
LM5 Gather information from listening and viewing experiences to enhance research
LM6 Use critical thinking skills to evaluate media and oral presentations
LM7 Use prior knowledge and experiences to facilitate comprehension of new oral texts
LM8 Identify rhythmic and time patterns in speech and literature
LM9 Identify and analyze themes and/or plots when listening and viewing
LM10 Use information gathered from listening and viewing experiences to expand research
LM11 Enhance use of critical thinking skills to evaluate media and oral presentations
LM12 Consider prior knowledge and experiences when attempting to understand the meaning of new texts
LM13 Appreciate rhythmic and time patterns of speech and literature
LM14 Select viewing and listening materials to support written text
LM15 Evaluate media and oral presentations analytically and critically
LM16 Organize prior knowledge and experiences to comprehend new texts
LM17 Organize and use viewing and listening materials to support written text

Subunit: Listening/Visual Literacy—Application
Competencies:

LA1 Listen attentively during oral reading
LA2 Use media as stimuli for learning and thinking
LA3 Develop knowledge of structure through art, music, and literature
LA4 Use electronic media to enhance and highlight language learning
LA5 Listen and view for entertainment and enjoyment
LA6 Use technology and other media as means of expressing ideas

Subunit: Listening/Visual Literacy—Multidisciplinary
Competencies:

LM1	Facilitate learning across curriculum through critical listening and viewing
LM2	Engage in individual, small-group, and whole-group listening and viewing activities
LM3	Develop language arts (e.g., viewing, listening) projects collaboratively
LM4	Investigate language and cultural differences through listening and viewing activities
LM5	Participate in a community of learners through productive listening

Subunit: Oral Communication—Structure
Competencies:

OS1	Refine oral communication skills
OS2	Demonstrate knowledge of grammar, usage, and syntax when presenting
OS3	Select topics and vocabulary suitable to audience
OS4	Organize notes and ideas for speaking
OS5	Use language imaginatively
OS6	Modulate voice to meaning when interpreting literature orally
OS7	Organize notes and ideas for formal, semiformal and informal presentations of information
OS8	Refine speaking techniques for formal, semiformal, and informal settings
OS9	Develop repertoire of organizational strategies for presenting information orally
OS10	Expand vocabulary to fit topic
OS11	Select topics suitable to audience, situation, and purpose
OS12	Select appropriate strategies when organizing notes and ideas for speaking

Subunit: Oral Communications—Meaning Construction
Competencies:

OM1	Make connections between prior knowledge and new information for oral presentations
OM2	Participate in informal speaking activities
OM3	Use interviewing techniques to gather information
OM4	Communicate orally to entertain and to inform
OM5	Participate in group communication activities
OM6	Take and organize notes when preparing speech/presentation
OM7	Interpret texts orally to illustrate meaning
OM8	Respond to needs of various audiences
OM9	Gather and assess information for speaking
OM10	Communicate orally to inform and persuade
OM11	Prepare and deliver formal speech/presentation
OM12	Participate in a variety of oral interpretations
OM13	Assess needs of audience and adjust language and presentation according to their knowledge
OM14	Analyze and synthesize information for speaking
OM15	Describe effectiveness of literary selection
OM16	Describe topic or idea in order to clarify personal/audience thinking
OM17	Analyze and synthesize information gathered from a variety of sources for speaking
OM18	Describe validity and/or quality of a literary selection and justify selection
OM19	Interpret orally a variety of literature
OM20	Describe topic or idea to clarify meaning for others

Subunit: Oral Communication—Application
Competencies:

OA1	Become proficient at using interviewing techniques
OA2	Give an oral interpretation for a specific audience
OA3	Develop and apply oral communication skills for cooperative/collaborative learning
OA4	Use oral communication for a variety of purposes and audiences (e.g., negotiations, book reviews, rationales)
OA5	Develop and apply decision-making strategies
OA6	Practice interviewing techniques
OA7	Apply interviewing techniques to purposeful interviews
OA8	Focus oral interpretation on a specific audience

Subunit: Oral Communications—Multidisciplinary
Competencies:

OM1	Value thinking and language of others
OM2	Develop oral projects collaboratively
OM3	Be involved in individual, small-group, and whole-group language activities
OM4	Participate actively in a community of learners
OM5	Investigate language and cultural differences through oral language activities

Unit: Mathematics Literacy

NOTE: This content was extracted from the 9-12 cluster of Ohio's Model Mathematics Program. Due to statewide initiatives other than Tech Prep, this literacy unit was not altered to meet competency-based criteria. Each literacy unit forms a critical link between academic teachers and members of business, industry, and labor. [See "The TCP Process" for more information.]

Subunit: Numbers and Number Relations

Competencies:

NR1	Compare, order, and determine equivalence of real numbers
NR2	Estimate answers, compute, and solve problems involving real numbers
NR3	Compare and contrast real number system, rational number system, and whole number system
NR4	Extend knowledge to complex number system and develop facility with its operation

Subunit: Measurement

Competencies:

M1	Estimate and use measurements
M2	Understand need for measurement and probability that any measurement is accurate to some designated specification
M3	Understand and apply measurements related to power and work
M4	Understand and apply measurement concepts of distance-rate-time problems and acceleration problems
M5	Use real experiments to investigate elasticity, heat, sound, electricity, magnetism, light, acceleration, velocity, energy, and gravity
M6	Use real-world problem situations involving mass and weight
M7	Use real-world problem situations involving simple harmonic motion
M8	Establish ratios with and without common units
M9	Construct and interpret maps, tables, charts, and graphs as they relate to real-world mathematics
M10	Understand and solve rate-change problems
M11	Understand and solve right triangle relationships as they relate to measurement, specifically to Pythagorean theorem
M12	Graph and interpret ordered pairs
M13	Compute total sales from a variety of items
M14	Comprehend and compute rates of growth or decay
M15	Comprehend, compute, and interpret real problems involving annuities

Subunit: Measurement (continued)

Competencies:

M16	Develop an ability to identify real problems and provide possible solutions
M17	Express and apply different types of measurement scales
M18	Identify area and volume

Subunit: Estimation and Mental Computation

Competencies:

E1	Use estimation to eliminate choices in multiple-choice tests
E2	Use estimation to determine reasonableness of problem situations in a wide variety of applications
E3	Estimate shape of graphs of various functions and algebraic expressions
E4	Use mental computation when computer and calculator are inappropriate

Subunit: Data Analysis and Probability

Competencies:

D1	Organize data into tables, charts, and graphs
D2	Understand and apply measures of central tendency, variability, and correlation
D3	Use curve fitting to predict from data
D4	Use experimental or theoretical probability, as appropriate, to represent and solve problems involving uncertainty
D5	Use computer simulations and random number generators to estimate probabilities
D6	Test hypotheses using appropriate statistics
D7	Read, interpret, and use tables, charts, and graphs to identify patterns, note trends, draw conclusions, and make predictions
D8	Identify probabilities of events involving unbiased objects
D9	Use sampling and recognize its role in statistical claims
D10	Design a statistical experiment to study problem, conduct experiment, and interpret and communicate outcomes
D11	Describe normal curve in general terms and use its properties
D12	Create and interpret discrete probability distributions
D13	Understand concept of random variable
D14	Apply concept of random variable to generate and interpret probability distributions, including binomial, uniform, and chi square

Subunit: Algebra
Competencies:

A1	Describe problem situations by using and relating numerical, symbolic, and graphical representations
A2	Use language and notation of functions in symbolic and graphing settings
A3	Recognize and use equivalent zeros of a function, roots and the solution of an equation in terms of graphical and symbolic representations
A4	Describe and use logic of equivalence in working with equations, inequalities, and functions
A5	Develop graphical techniques of solution for problem situations involving functions
A6	Explore and describe characterizing features of functions
A7	Make arguments and proofs in algebraic settings
A8	Factor difference of two squares
A9	Identify slope, midpoint, and distance
A10	Explore and combine rational functions
A11	Explore factoring techniques
A12	Solve quadratic equations by factoring and formula
A13	Set up and solve linear equations
A14	Solve systems of linear equations with two variables
A15	Describe geometric situations and phenomena using variables, equations, and functions
A16	Describe measures of central tendency, mean, median, mode, and variance algebraically and graphically
A17	Represent inequalities on number line and in coordinate plane
A18	Use coordinate arguments in making geometric proofs
A19	Symbolize transformations of figures and graphs
A20	Explore geometric basis for functions of trigonometry
A21	Graph linear functions
A22	Develop and use vectors to represent direction and magnitude including operations
A23	Use polar and parametric equations to describe, graph, and solve problem situations
A24	Represent sequences and series as functions both algebraically and graphically
A25	Explore recursive functions and procedures using spreadsheets, other computer utilities, and appropriate notions
A26	Describe and solve algebraic situations with matrices
A27	Describe and use inverse relationship between functions including exponential and logarithmic

Subunit: Algebra (continued)
Competencies:

A28	Analyze and describe errors and error sources that can be made when using computers and calculators to solve problems
A29	Decide whether problem situation is best solved using computer, calculator, paper and pencil, or mental arithmetic/estimation techniques
A30	Explore relationships between complex numbers and vectors
A31	Make arguments concerning limits, convergence and divergence in context involving sequences, series, and other types of functions
A32	Represent transformations in plane with matrices
A33	Contrast and compare algebra's of rational, real, and complex numbers with characteristics of a matrix algebra system
A34	Construct polynomial approximations of a function over specified intervals of convergence
A35	Examine complex numbers as zeros of functions
A36	Translate verbal statements into symbolic language
A37	Simplify algebraic expressions
A38	Use laws and exponents (including scientific notation)
A39	Expand and extend idea of vectors and linear algebra to higher dimensional situations
A40	Use the idea of independent basis elements for a vector space and associated fundamental concepts of finite dimensional linear algebra
A41	Develop and communicate arguments about limit situations
A42	Use matrices to describe and apply transformations
A43	Develop and use polar and parametric equations to represent problem situations
A44	Explore proofs by mathematical induction

Subunit: Geometry
Competencies:

G1	Create and interpret drawings of three-dimensional objects
G2	Represent problem situations with geometric models and apply properties of figures
G3	Apply Pythagorean theorem
G4	Demonstrate knowledge of angles and parallel and perpendicular lines
G5	Explore inductive and deductive reasoning through applications to various subject areas
G6	Translate between synthetic and coordinate representations
G7	Identify congruent and similar figures using transformation with computer programs
G8	Deduce properties of figures using transformations and coordinates
G9	Use deductive reasoning
G10	Explore compass and straightedge constructions in context of geometric theorems
G11	Demonstrate knowledge of and ability to use proof
G12	Use variety of proof techniques (e.g., synthetic, transformational, and coordinate)
G13	Use variety of proof formats, including T-proof (i.e., two-column) and paragraph proof
G14	Explore different proof strategies
G15	Investigate different proofs of theorems
G16	Develop knowledge of an axiomatic system
G17	Apply transformations and coordinates in problem solving
G18	Represent problem situations with geometric models and apply properties of figures
G19	Deduce properties of figures using vectors
G20	Analyze properties of Euclidean transformations and relate translations to vectors
G21	Apply vectors in problem solving
G22	Develop further knowledge of axiomatic systems by investigating and comparing various geometry's

Subunit: Patterns, Relations, and Functions
Competencies:

P1 Model real-world phenomena with polynomial and exponential functions
P2 Explore relationship between zeros and intercepts of functions
P3 Translate among tables, algebraic expressions, and graphs of functions
P4 Use graphing calculator or computer to generate graph of a function
P5 Explore relationship between a linear function and its inverse
P6 Describe and use characteristics of polynomial functions in problem-solving situations
P7 Explore conic sections and graph using graphing calculator or computer
P8 Apply trigonometric functions to problem situations involving triangles
P9 Discover relationships between algebraic description, kind, and properties of conic
P10 Explore periodic real-world phenomena using sine and cosine functions
P11 Analyze effects of parameter changes on graphs
P12 Use graphing calculator or computer to graph functions
P13 Develop an knowledge of rational and transcendental functions
P14 Understand connections between trigonometric and circular functions
P15 Use circular functions to model periodic real-world functions
P16 Solve trigonometric equations and verify trigonometric identities
P17 Understand connections between trigonometric, exponential, and logarithmic functions and polar coordinates, complex numbers, and series
P18 Model real-world phenomena with a variety of functions
P19 Graph using polar coordinates
P20 Explore graphs in three dimensions
P21 Explore functions of several variables
P22 Explore recursive functions using spreadsheets and/or programming languages

Unit: Science Literacy

NOTE: This content was extracted from the 9-12 cluster of Ohio's Draft Model Science Program. Due to statewide initiatives other than Tech Prep, this literacy unit was not altered to meet competency-based criteria. Each literacy unit forms a critical link between academic teachers and members of business, industry, and labor. [See "The TCP Process" for more information.]

Subunit: Scientific Inquiry
Competencies:

Q1 Check the appropriateness and accuracy of measures and computations using various strategies (e.g., estimations, unit analysis, determination of significant figures)
Q2 Use ratios, proportions, and probabilities in appropriate problem situations
Q3 Translate information from and represent information in various forms with equal ease (e.g., tables, charts, graphs, diagrams, geometric figures)
Q4 Use existing algebraic formulas and create new ones in appropriate problem-solving situations
Q5 Estimate and justify probabilities of outcomes of familiar situations based on experimentation and other strategies
Q6 Invent apparatus and mechanical tools needed to perform unique tasks in various situations
Q7 Identify, compare, and contrast different modes of inquiry, habits of mind, and attitudes and dispositions
Q8 Design investigations that are safe and ethical (i.e., obtain consent and inform others of potential outcomes, risks and benefits, and show evidence of concern for human health and safety, concern for non-human species)
Q9 Make and read scale drawings, maps, models, and other representations to aid planning and understanding
Q10 Seek elaboration and justification of data and ideas, and reflect on alternative interpretations of the information
Q11 Use appropriate units for counts and measures
Q12 Create and use databases (electronic and other) to collect, organize, and verify data and observations
Q13 Design and conduct investigations with multiple variables
Q14 Communicate the results of investigations clearly in a variety of situations

Subunit: Scientific Inquiry (continued)
Competencies:

Q15 Examine relationships in nature, offer alternative explanations for the observations, and collect evidence that can be used to help judge among explanations

Q16 Trace the development (e.g., history, controversy, and ramifications) of various theories, focusing on supporting evidence and modification with new evidence

Q17 Select, invent, and use tools, including analog and digital instruments, to make and record direct measurements

Q18 Observe and document events and characteristics of complex systems

Q19 Explain the influence of perspective (e.g., spatial, temporal, and social) on observation and subsequent interpretations

Q20 Create multiple representations of the same data using a variety of symbols, descriptive languages, mathematical concepts, and graphic techniques

Q21 Generate testable hypotheses for observations of complex systems and interactions

Q22 Document potentially hazardous conditions and associated risks in selected homes and public areas

Q23 Participate in public debates, relying on documented and verified data to construct and represent a position on scientific issues

Q24 Construct and test models of physical, biological, social, and geological systems

Q25 Read, verify, debate, and, where necessary, refute research published in popular or technical journals of science (e.g., *Discover*, *Omni*, *Popular Mechanics*)

Q26 Explore discrepant events and develop and test explanations of what was observed

Q27 Conduct theory-based research using surveys, observational instruments, and other methods

Q28 Modify personal opinions, interpretations, explanations, and conclusions based on new information

Q29 Analyze error and develop explanations in various domains

Q30 Formulate taxonomic schemes based upon multivariate models that help to explain similarities and differences in form, distribution, behavior, survival, and origin of objects and organisms

Q31 Demonstrate various logical connections between related concepts (e.g., entropy, conservation of energy)

Q32 Account for discrepancies between theories and observations

Q33 Analyze the changes within a system when inputs, outputs, and interactions are altered

Subunit: Scientific Inquiry (continued)
Competencies:

Q34 Create, standardize, and document procedures

Q35 Determine the sources of significant disparities between the predicted and recorded results and change research procedures to minimize disparities

Q36 Research, locate, and propose applications for abstract patterns (e.g., fractals, Fibonacci sequences, string theory, orbitals)

Q37 Recognize and utilize classification systems for particles, elements, compounds, phenomena, organisms, and others for exploring and predicting properties and behaviors

Q38 Suggest and defend alternative experimental designs and data explanations (e.g., sampling, controls, safeguards)

Q39 Recognize and communicate differences between questions that can be investigated in a scientific way and those that rely on other ways of knowing

Q40 Draw conclusions based on the relationships among data analysis, experimental design, and possible models and theories

Q41 Suggest new questions as a result of reflection on and discussions about their own scientific investigations

Q42 Investigate, assess, and comment on strengths and weakness of the descriptive and predictive powers of science

Q43 Create new information from representations of data in a variety of forms (e.g., symbols, descriptive languages, graphic formats) utilizing a variety of techniques (e.g., interpolations, extrapolations, linear regressions, central tendencies, correlation's)

Subunit: Scientific Knowledge
Competencies:

K1 Investigate various types of dynamic equilibrium (e.g., biological, geological, mechanical, chemical)
K2 Investigate the relationship between the rates of energy exchange and the relative energy level of components with systems (e.g., tropic levels of ecosystems, osmosis, rate of heating and cooling, storms)
K3 Investigate patterns in the natural world (e.g., heredity, crystalline structures, population and resource distributions, diffraction, dispersion, polarization)
K4 Investigate models and theories that help to explain the interactions of components in systems (e.g., conservation of mass, energy, and momentum; food webs; natural selection; entropy; plate tectonics; chaos; relativity; social-psychology)
K5 Investigate degrees of kinship among organisms and groups of organisms
K6 Investigate the limits of the definition of life, and investigate organisms and physical systems that exist at or near these limits (e.g. viruses, quarks, black holes)
K7 Investigate estimates and measurements of a wide range of distances and rates of change
K8 Investigate the historical development of theories of change over time (e.g., natural selection, continental drift, the big bang, geologic change)
K9 Investigate physical and chemical changes in living and non-living systems (e.g., photosynthesis, weathering processes, glaciation, thermal effects of materials, energy cells)
K10 Investigate simulations of nuclear change (e.g., radioactivity, half life, carbon dating)
K11 Investigate conservation principles associated with physical, chemical, and nuclear changes
K12 Formulate descriptions of the impacts of various forms of mechanical and electromagnetic waves on various organisms on each other over time
K13 Formulate models and hypotheses for patterns in the natural world (e.g., earth structures, transportation systems, migrations, communications, constellations)
K14 Formulate explanations for the influences of objects and organisms on each other over time
K15 Formulate and interpret explanations for change phenomena (e.g., mass extinction's, stellar evolution, punctuated equilibrium, molecular synthesis)

Subunit: Scientific Knowledge (continued)
Competencies:

K16	Formulate and interpret explanations for the magnitudes of diversity at different periods of geologic time (e.g., mutation, global cataclysms, continental drift, competition, mass extinction's)
K17	Formulate interpretations of the structure, function, and diversity in a variety of organisms and physical systems (e.g., DNA and RNA variants, nucleons, interaction particles)
K18	Formulate understandings of geologic time (e.g., millennia, periods, epochs)
K19	Formulate an understanding of the historical development of the model of the universe
K20	Formulate explanations and representations of the production, transmission, and conservation of energy in biological and physical systems (e.g., weather, volcanism, earthquakes, electricity, magnetism, cellular respiration)
K21	Formulate models and hypotheses about patterns in the natural world (e.g., social behavior, molecular structure, energy transformation, entropy, randomness, aging, chaos, hormonal cycles)
K22	Formulate interpretations of the relationship between energy exchange and the interfaces between components within systems
K23a	Formulate estimations for the range of energies within and between various phenomena (e.g., thermal, electromagnetic, thermonuclear, chemical, electrical)
K23b	Formulate explanations for the historical development of descriptions of motions interactions and transformations of matter and energy (e.g., classical Newtonian mechanics, special and general relativity, chaos)
K24	Formulate models that can be used to describe fundamental molecular interactions in living and non-living systems (e.g., cell membranes, semiconductors).
K25	Formulate an understanding of the degree of relationship among organisms and objects based on molecular structure (e.g., proteins, nucleic acids)
K26	Formulate hypotheses and models that may account for observable events (e.g., electricity and magnetism, gravitation, atoms, bonding, chemical reactions, quantum effects, energy flow on biological systems, predator-prey relationships)
K27	Formulate models and hypotheses about change over time (e.g., natural selection, speciation, punctuated equilibrium, phyleytic gradualism, stellar evolution, plate tectonics, radioactive decay, quantum mechanical theory)

Subunit: Scientific Knowledge (continued)
Competencies:

K28 Formulate lists of limitations and propose refinements of standard classification systems (e.g., periodic table, IUPAC, Linnean, standard model)

K29 Formulate specific cases of limitations and possible exceptions of theories and principles regarding the interactions of moving objects and organisms (e.g., fluid flow in vessels, motion near the speed of light, Heisenberg uncertainty principle, meteorological prediction, local variation and diversity, predicting earthquakes, energy transport in cellular respiration)

K30 Formulate plans and contingencies that can be used to accommodate for changes to and stresses on systems (e.g., wildlife and habitat management, corrosion prevention, noise abatement, structure design)

K31 Formulate models of molecular, atomic, ionic, and subatomic structures and the physical and biological implications of these structures (e.g., genes, nucleons, quarks)

K32 Formulate estimates for a wide range of measurements and scales (e.g., angstroms to light years)

K33 Formulate and interpret representations of time from origin to present accounting for phenomena of scale (e.g., smoothness, punctuation's, chaos)

K34 Formulate interpretations of the historical development of various theories of possible causes of diversity among physical and biological phenomena (e.g., the works of Aristotle, Mendel, Darwin, McClintock)

K35 Formulate models and hypotheses that can be used to explain the interactions of components within technological and ecological systems

Subunit: Conditions for Learning Science
Competencies:

C1 Participate actively in dialogue about and resolution of community issues

C2 Assess information from various countries in the original language or translated form to ascertain the perspectives of many cultures

C3 Analyze the scientific ideas presented in science fiction stories and films

C4 Perform and repeat investigations to verify data, determine regularity, and reduce the impact of experimental error

C5 Present the results of investigations in a variety of forums

C6 Contribute to the decisions regarding topics for investigation

C7 Use various creative means to communicate interpretations of scientific ideas, concepts, phenomena, and events

C8 Consider the scientific thinking and language of others

C9 Individually and collaboratively produce clearly written representations of investigative results

C10 Fulfill responsibilities as part of a research group

C11 Select and utilize resources by various criteria (e.g., efficiency, effectiveness, health, safety) that are appropriate to the investigations being conducted by groups

C12 Present persuasive argument based on the scientific aspects of controversial issues

C13 Collect, store, retrieve, and manipulate information with available t technologies alleges that may range from hand processes up through computer applications

C14 Investigate social issues with a scientific perspective (e.g., human rights, wellness, economics, futurism, environmental ethics)

C15 Keep journals of observations and inferences made over an extended period of time and reflecting upon the impact of these recorded ideas on their thinking and actions

C16 Examine the intellect, perspectives, and ethics of notable scientists

C17 Collect and analyze observations made over extended periods of time and compare these to scientific theories

C18 Create presentations of scientific understandings using diverse modes of expressions

C19 Conduct formal scientific debates in the classroom

C20 Wonder about the likelihood of events that may occur by chance or coincidence

C21 Plan and conduct field trips and experiences for small and large groups

C22 Analyze the historical context which leads to and has lead to scientific t theories

Subunit: Conditions for Learning Science (continued)

Competencies:

C23 Seek information on topics of personal scientific interest from a variety of sources

C24 Conduct learner-developed investigations independently and collaboratively over periods of week and months

C25 Listen attentively and critically to presentations of scientific information made by others

C26 Conduct analyses of propaganda related to scientific issues

C27 Perform investigations that require observations over varying periods of time

C28 Experience scientific concepts as interpreted by other cultures through multimedia and local and global specialists

C29 Access appropriate technology to perform complicated, time-consuming tasks

C30 Relate historical accounts of science to the cultural context in which they were written

C31 Work as a contributing member of a collaborative research group

C32 Examine the influences of social and political structures and realities that contribute to inquiry about scientific issues

C33 Use technology (e.g., desktop publishing, teleconferencing, networking) to communicate scientific ideas

C34 Explore and analyze a variety of perspectives on science (e.g., works by men and women of many racial, ethnic, and cultural groups)

C35 Lead groups of learners of various ages in designing, planning, and conducting science activities

C36 Respect the scientific thinking of others and self

C37 Recognize and contrast different epistemologies

C38 Develop possible courses of action in response to scientific issues of local and global concern

C39 Determine the validity of research conclusions in relation to the design, performance, and results

C40 Develop multimedia presentations of group and individual research projects and investigations appropriate for a variety of audiences and forums

C41 Produce interesting and scientifically correct stories and present them using various modes of expression

C42 Reflect on the ideas and content found in their own journal records

C43 Examine ambiguous results and formulate explanations

C44 Recognize and synthesize the contributions to scientific thought of individuals from many cultures

Subunit: Conditions for Learning Science (continued)

Competencies:

C45 Construct models and simulations of the component structures and functions of living and non-living entities

C46 Lead multi-age groups in the examination of and planned resolution for scientific issues

C47 Recognize and choose members of research teams based upon the merit of their ideas and skills

C48 Construct a portfolio of products, documentation, and self-evaluations of his/her own abilities, skills, and experiences

C49 Synthesize scientific information from a variety of sources

C50 Evaluate and prioritize scientific issues based upon risk-benefit analyses

C51 Refining scientific skills from a variety of experiences

Subunit: Applications for Science Learning

Competencies:

A1 Answer student-determined questions by designing databases and drawing inferences from the analyses of the information in these data bases

A2 Make personal behavior decisions by interpreting information that has a scientific basis

A3 Propose courses of action that will validate and demonstrate personal understandings of scientific principles

A4 Guide other learners in their understanding of the interactions of technologies and society at various periods in time

A5 Promote and carry out practices that contribute to a sustainable environment

A6 Study and propose improvements in public services and systems in their community

A7 Choose consumer materials utilizing personal and environmental risk and benefit information

A8 Make inferences and draw conclusions using databases, spreadsheets, and other technologies

A9 Do simple trouble-shooting on common electrical and mechanical s ystems, identifying and eliminating possible causes of malfunctions

A10 Construct devices that perform simple, repetitive actions

A11 Investigate the functionality of various geometric shapes in the natural world and the designed world (e.g., translations from spherical to plane representations cause distortions, triangular shapes contribute to rigidity and stability in structures, round shapes minimize boundary for a given capacity)

A12 Make decisions regarding personal and public health

A13 Evaluate the social and ecological risks and benefits resulting from the use of various consumer products

A14 Analyze the contributions of advances in technology through history to his/her everyday life

A15 Identify and reduce risks and threats to a sustainable environment

A16 Extend the limits of human capabilities using technological enhancements

A17 Use and recognize various propaganda techniques

A18 Solve unique problems using the results of systematic analyses

A19 Choose everyday consumer products that utilize recent innovation and pass appropriate performance criteria

A20 Refine personal career interests through investigations of the diversity of manufacturing, research, service, and invention processes

Subunit: Applications for Science Learning (continued)
Competencies:

A21 Predict and investigate the working of toys and tools while controlling and manipulating variables (e.g., friction, gravity, forces)

A22 Write, follow, modify, and extend instructions (e.g., equations, algorithms, formulas, flow diagrams, illustrations)

A23 Create products, make inferences, and draw conclusions using databases, spreadsheets, and other technologies

A24 Predict various scenarios and propose solutions to community issues using scientific information (e.g., actuarial tables, census data, topographic maps, incidence data, climatic data)

A25 Use scientific evidence to consider options and formulate positions about the health and safety of others and him/herself

A26 Search for, use, create, and store objects and information using various strategies and methods of organization and access

A27 Research and write environmental impact statements of his/her own design

A28 Compare school-based science perspectives with those gained through cutting-edge technological applications

A29 Design management plans for natural and human-altered environments (e.g., woodlots, patios, lots, lawns, farmlands, forests)

A30 Refine personal career interests

A31 Promote public awareness of the interaction of technology with social i issues

A32 Advocate and propose courses of action for local and global scientific issues using global networks

A33 Use appropriate technologies to prepare and present the findings of investigations incorporating tables, graphs, diagrams, and text

A34 Make informed consumer choices by evaluating and prioritizing information, evidence, and strategies

A35 Develop an informed point-of-view that allows for validation or refutation of the scientific statements and claims of advocated before pursuing courses of action (e.g., contributing support, signing petitions, casting votes)

A36 Differentiate between observations and inferences in the exploration of evidence related to personal, scientific, and community issues

A37 Develop and write environmental impact and safety and hygiene management plans

A38 Use technology to collect, analyze, and communicate information (e.g., electronic networks, desktop publishing, remote sensing, graphing calculators, satellite telemetry, and others)

A39 Design, construct, and market inventions

Unit: Technology Literacy

NOTE: Over 500 Ohio business, industry, and labor representatives examined, altered, and then verified the content for this unit during the TCP Process. The original content was extracted from the Report of the Task Force on Technology Competence—Learner Goals for All Minnesotans, published by the Minnesota State Council on Vocational Technical Education. The Technology Literacy unit forms a critical link between all teachers and stresses the importance of technological impact on teaching and learning. [See "The TCP Process" for more information.]

Competencies:

T1 Demonstrate a systems view of technology based on the interdependence of social, political, economic, and ecological systems
T2 Assess the career, family, and personal development implications of technological change
T3 Demonstrate continuous learning via technology
T4 Demonstrate global appreciation for technology's potential effects on cultures, geographic areas, and the environment
T5 Apply historical perspective on technology to the development and use of new technologies
T6 Apply diverse technologies to store, access, process, create, and communicate information needed to solve problems
T7 Apply legal principles and ethical conduct to the use of technology
T8 Demonstrate competency in mathematics, science, social sciences, communication, and computer skills through the analysis, design, and evaluation of technological systems
T9 Analyze the potential of alternative technological systems to solve problems and/or to extend human capabilities
T10 Use a variety of tools, materials, and equipment in solving problems and extending human capabilities
T11 Assess risks and benefits of technological developments from an ecological, economic, social, and political perspective
T12 Value human diversity as part of a team in suggesting, designing, and testing solutions to technological problems

Unit: Employability Skills

Competency: **Develop a career plan**

Competency Builders:

Identify current interests and aptitudes
Identify common barriers to employment
Describe strategies to overcome employment barriers
Locate resources for finding employment
Research job trends
Identify career options
Identify advantages and disadvantages of career options (in addition to other than monetary)
Identify job requirements
Investigate education/training opportunities
Evaluate personal strengths and weaknesses

Competency: Prepare for employment

Competency Builders:

Identify traditional and non-traditional employment sources
Identify present and future employment opportunities (by geographic location)
Research job opportunities, including non-traditional careers
Compare salary ranges and benefit packages
Compile occupational profile
Identify rights and responsibilities of equal employment opportunity laws
Design resume and cover letter
Target resume
Secure references
Investigate generic and specific employment tests (e.g., civil service exam; drug screening)
Use follow-up techniques to enhance employment potential
Demonstrate legible written communication skills using correct grammar, spelling, punctuation, and concise wording
Describe methods for handling illegal questions on job application forms and during interviews
Write letter of application
Research prospective employer and services performed
Explain critical importance of personal appearance, hygiene, and demeanor
Interpret job description
Demonstrate appropriate interview question and answer techniques
Demonstrate methods for handling difficult interview questions
Evaluate job offers
Write letter of acceptance
Write letter of declination
Demonstrate good listening skills
Ask for the job tactfully
Participate in extracurricular activities (e.g., student government, community projects,)

Competency: Evaluate the importance of self-esteem as an employability skill

Competency Builders:

Identify factors that affect self-esteem
Compare effects of low self-esteem and high self-esteem
Identify strategies to promote positive self-esteem

Competency: Demonstrate job retention skills

Competency Builders:

Identify employer expectations regarding job performance, work habits, attitudes, personal appearance, and hygiene
Exhibit appropriate work habits and attitude
Demonstrate ability to set priorities
Identify behaviors to establish successful working relationships
Identify alternatives for dealing with harassment, bias, and discrimination based on race, color, national origin, sex, religion, handicap, or age
Identify opportunities for advancement
List reasons for termination
List consequences of being absent frequently from job
List consequences of frequently arriving late for work
Demonstrate interpersonal relations skills (i.e., verbal and written)
Demonstrate negotiation skills
Demonstrate teamwork
Follow chain-of-command
Exhibit appropriate job dedication

Competency: Demonstrate knowledge of work ethic

Competency Builders:

Define work ethic
Identify factors that influence work ethic
Differentiate law and ethics
Describe how personal values are reflected in work ethic
Describe how interactions in the workplace affect personal work ethic
Describe how life changes affect personal work ethic

Competency: Exhibit appropriate work ethic

Competency Builders:

Use time-management techniques
Avoid personal activity during work hours
Attend work as scheduled
Adhere to company and/or governmental policies, procedures, rules, and regulations
Exercise confidentiality
Demonstrate appropriate human relations skills
Adhere to rules of conduct
Accept constructive criticism
Offer constructive criticism
Take pride in work
Resolve conflict
Manage stress
Avoid sexual connotations and harassment
Adjust to changes in the workplace
Demonstrate punctuality
Assume responsibility for personal decisions and actions
Take responsibility for assignments
Follow chain-of-command

Competency: Apply decision-making techniques

Competency Builders:

Identify decision to be made
Identify ownership of decision to be made
Identify possible alternatives and their consequences
Make decisions based on facts, legality, ethics, goals, and/or culture
Apply time factor(s)
Present decision to be implemented
Evaluate decision made
Take responsibility for decision

Competency: Apply problem-solving techniques

Competency Builders:

Identify problem
Select appropriate problem solving tools/techniques
Identify root problem cause(s)
Track root problem cause(s)
Identify possible solutions and their consequences (e.g., long term, short term, crisis)
Use resources to explore possible solutions to problem
Contrast advantages and disadvantages of each solution
Identify appropriate action
Evaluate results
Identify post-preventive action

Competency: Exhibit characteristics for job advancement

Competency Builders:

Display positive attitude
Demonstrate knowledge of position
Perform quality work
Adapt to changing situations and technology
Demonstrate capability/responsibility for different positions
Identify characteristics of effective leaders
Identify opportunities for leadership in work place/community
Demonstrate initiative to affect change in workplace
Participate in continuing education/training program
Responds appropriately to criticism from employer, supervisor, or other employees
Exhibit awareness of corporate culture
Prepare for job setbacks
Exhibit continual growth based on performance evaluation
Set realistic goals

Unit: Professionalism

Competency: **Project professional image**

Competency Builders:

Define professionalism
Exhibit professional appearance
Exhibit professional manners
Project professional attitude
Identify individuals' vital role in organization
Exhibit proper etiquette in professionally-related situations

Competency: **Achieve individual and professional goals**

Competency Builders:

Set flexible, realistic, and measurable goals
Identify potential barriers to achieving goals
Identify strategies for addressing barriers to goal achievement
Breakdown long-term goals into short-term goals
Prioritize goals
Commit to goals
Adjust goals
Obtain support for goals
Reward goal achievement

Competency: **Manage personal finances**

Competency Builders:

Explain need for personal management records
Balance checkbook
Identify tax obligations
Analyze how credit affects financial security
Compare types and methods of investments
Compare types and methods of borrowing
Compare types and methods of insurance
Compare types of retirement options/plans
Identify discriminatory vs. non-discriminatory expenditures

Competency: Support community well-being

Competency Builders:

Identify environmental, educational, and social issues
Participate in social and/or community activities

Competency: Achieve organizational goals

Competency Builders:

Evaluate personal goals in relation to organizational goals
Monitor progress by evaluating feedback
List responsibilities in relation to organization goals
Accomplish assigned tasks
Exercise responsibility in relation to organizational goals
Set appropriate personal performance standards
Communicate goals with supervisor and peers
Demonstrate knowledge of products and services
Promote organizational image and mission

Competency: Demonstrate positive relations in the workplace

Competency Builders:

Identify personality types of self and other
Identify various management styles
Support employer expectations
Support employer decisions
Accept constructive criticism
Give constructive feedback
Adapt to changes in workplace
List factors to consider before resigning
Write letter of resignation

Competency: **Manage stressful situations**

Competency Builders:

Accept stress as part of daily life
Identify personal and professional factors contributing to stress
Describe physical and emotional responses to stress
Evaluate positive and negative effects of stress on productivity
Identify strategies for reducing stress
Implement strategies to manage stress
Create strategies for developing and maintaining support systems

Competency: **Analyze effects of family on work and work on family**

Competency Builders:

Identify how family values, goals, and priorities are reflected in work place
Identify responsibilities and rewards associated with paid and non-paid work
Identify responsibilities and rewards associated with families
Explain how family responsibilities can conflict with work
Explain how work can conflict with family responsibilities
Explain how work-related stress can affect families
Explain how family-related stress can affect work
Identify family support systems and resources
Identify work-related support systems and resources
Communicate with family regarding work

Competency: **Apply lifelong learning skills**

Competency Builders:

Define lifelong learning
Identify factors that cause need for lifelong learning
Analyze effects of change
Identify reasons why goals change
Describe importance of flexibility and adaptability
Evaluate need for continuing education/training

Competency: Manage professional development

Competency Builders:

Identify career opportunities
Modify career plan
Participate in continuing education/training opportunities
Document continuing education/training
Read profession-related manuals, technical journals, and periodicals
Attend meetings, workshops, seminars, conferences, and demonstrations
Participate in professional organizations
Build personal/professional mentor relationship
Build personal/professional support system
Build professional network
Strengthen communication skills
Strengthen leadership skills
Strengthen management skills

Unit: Teamwork

Competency: Demonstrate knowledge of teamwork

Competency Builders:

Define empowerment
Differentiate work groups and teams
Identify conditions essential to teamwork (e.g., brainstorming)
Explain influence of culture (e.g., corporate, community) on teamwork
Identify appropriate situations for using teams
Define team structures (e.g., cross functional, quality improvement, task force, quality circles)
Identify team building concepts
Describe characteristics and dynamics of teams
Identify characteristics of effective team leaders and members
Identify responsibilities of a valuable team member
Identify methods of involving each member of a team
Explain how individuals from various backgrounds contribute to work-related situations (e.g., technical training, cultural heritage)
Explain the purpose of facilitators
Define consensus
Define reward/recognition system

Competency: Demonstrate teamwork

Competency Builders:

Identify purpose of team and intended goal (include time frames)
Structure team around purpose
Define responsibilities of team members
Contribute to efficiency and success of team
Work toward individual and team milestones
Analyze results of team project
Facilitate a team meeting
Assist team member(s) with problem
Monitor time frame
Stress continuous improvement
Accept failure as part of learning

Competency: Use teamwork to solve problems

Competency Builders:

Identify appropriate situations for using teams
Use problem-solving process in a team setting
Identify quality management processes/techniques
Identify quality assurance processes/techniques
Prepare presentation

Competency: Conduct team meetings

Competency Builders:

Plan agenda
Schedule meeting and location
Invite appropriate personnel
Solicit outside speakers as needed
Assign someone to take minutes
Facilitate introductions
Invite questions and comments and group participation
Focus team on agenda items
Assign appropriate action, time frame and accountability to tasks
Monitor time
Close meeting on time
Publish minutes in timely manner
Set ground rules
Avoid placing individual agendas above the group's agenda

Unit: Quality Assurance

Competency: Demonstrate knowledge of quality assurance

Competency Builders:

Explain the historical evolution of quality assurance (e.g., Deming, ISO 9000)
Explain changes brought about by quality leaders in the world
Explain the ISO 9000 process
Define quality terms
Define quality functions
Identify features of quality planning
Describe control devices used in functional areas (e.g., SPC, equipment)
Explain the relationship among organizational structures, policies, procedures, and quality assurance
Explain importance of internal and external customers
Identify internal and external customers
Describe successful efforts by industry to improve quality and/or reduce costs
Differentiate prevention and detection
Differentiate variable and attribute data
Identify types of coontrol charts
Explain how statistical techniques are tools used to control quality (e.g., SPC, DOE, CR)

Competency: Demonstrate knowledge of quality cost implications

Competency Builders:

Identify cost/quality objectives
Classify costs (i.e., direct and indirect, fixed and variable, methods and standards)
Classify quality costs (i.e., prevention, evaluation, pre-delivery failure, post-delivery failure)
Define produce liability
Interpret quality cost reports
Explain consumerism and liability prevention
Define safety terms of product
Identify safety responsibility within organization
Define contracts and torts
Differentiate express and implied warranty
Differentiate warranty and product liability
Explain how warranties are part of contract law
List questions that would need answering in liability claim

Competency: Demonstrate knowledge of engineering a quality product

Competency Builders:

Associate customer satisfaction with product characteristics (e.g., usefulness, price, operation, life, reliability, safety, cost of operation)
Define manufacturability
Identify steps in product design (e.g., brainstorming, thumbnail sketches, rendering)
Define reliability factors (e.g., cost, human, producibility)
Identify ways reliability is achieved (e.g., maintainability, good design, design simplification, design redundancy)
Explain the relationship of maintainability to reliability
Define failure
Explain the role of testing and reliability
Define value engineering
Define quality objectives
Identify cost components as they relate to quality objectives
Classify quality costs (i.e. preventive, evaluation, pre-delivery failures, post delivery failures)
Describe predictive maintenance

Competency: **Explain importance of interdepartmental relationships to quality assurance**

Competency Builders:

Explain need for everyone's commitment in assuring quality
Explain phrase "Everyone is a customer/supplier"
Define quality improvement team models
Explain the importance of top management's support of quality
Explain project selection
Explain project implementation
Explain project evaluation
Explain continuing improvement
Describe future trend of experiment design
Describe future trend of predictive maintenance

Competency: **Manipulate quality cost data**

Competency Builders:

Develop quality cost data
Translate cost reports
Graph quality cost data (e.g., pareto)

Competency: **Manipulate cost control data**

Competency Builders:

Develop cost control data
Analyze cost control reports
Provide cost control data
Provide advice on "Make or Buy" decisions (including economical lot size decisions)

Competency: Demonstrate knowledge of basic statistics

Competency Builders:

Describe data collection methods
Collect data
Organize data by flow chart
Interpret data by cause and effect diagrams
Define nominal, ordinal, interval, and ratio data
Define mean, median, and mode
Explain significance of standard deviation
Explain normal distribution

Competency: Demonstrate knowledge of scattergrams

Competency Builders:

Construct scattergram
Interpret for positive, negative, or no correlation between X and Y variables
Test for significance between one and five percent
Explain regression analysis

Competency: Demonstrate knowledge of probability theory

Competency Builders:

Define classical probability
Define empirical probability
Calculate probability for outcomes

Competency: Demonstrate knowledge of precontrol

Competency Builders:

Explain uses of precontrol
Calculate precontrol limits
Explain significance of the limits
Plot values on a precontrol chart
Explain "out-of-control" situation
Make decisions on green, yellow and red conditions

Competency: Demonstrate knowledge of process capability

Competency Builders:

Use X, R, USL, and LSL to determine process capability (upper and lower specification limits)
Calculate estimated process standard deviation
Plot right hand and left hand tail of process variation
Compute Z value for percent of probable defect for process
Calculate C_{PK} values that describe process capability
Describe skewed distributions
List probable causes of skewed distribution

Competency: Use quality control charts

Competency Builders:

Identify operational definitions for attribute criteria
Interpret histogram
Interpret scattergrams
Interpret NP chart
Interpret P chart
Interpret flowchart
Interpret cause-and-effect diagram
Construct P (percentage defective) chart for attributes
Plot control limits of P chart and data points
Check chart for out-of-control conditions
Construct an NP (number defective) chart with control limits and data
Construct C (count of defects) and U (number of defects per unit) charts
Check data on C and U charts
Construct flowchart
Construct cause-and-effect chart

Competency: Interpret $\overline{X}$ and R charts

Competency Builders:

Plot percentages for normal distribution
Test distribution for normality
Explain difference between common cause and special cause
Define an "in-control" process
Explain significance of an out-of-control point on $\overline{X}$ or R chart
Identify patterns and trends on control chart
Identify run up and run down
Test for middle third on control chart
Explain significance of middle third on control chart
Explain Rule of Sevens

Competency: Construct $\bar{X}$ and R charts

Competency Builders:

Arrange data into statistical sub-groups
Explain importance of random sampling
Compute $\bar{X}$ (i.e., average of values) and R (i.e., range of values in subgroup) within sample
Plot in $\bar{X}$ and R on chart
Construct control chart with $\bar{\bar{X}}$ (grand average) and R (average range) calculated
Calculate upper and lower control limits for $\bar{X}$-chart
Calculate upper and lower control limits for R-chart

Competency: Conduct process improvement studies

Competency Builders:

Analyze production methods and processes applying statistical process improvement techniques (e.g., SPC, C_{PK})
Identify appropriate statistical techniques for study (e.g., T-tests, F-test, capability, DOEX)
Identify major steps in conducting a study
Define "report" for a study (e.g., goal, objective, study conduct, results, conclusions, discussions)
Integrate results into the total system

Competency: Demonstrate knowledge of JIT

Competency Builders:

Define just-in-time concept (JIT)
Describe various production methodologies (e.g., standard cycle times, routings, standard quantities, multiple-machine tending)
Describe types of inventory control (e.g., Kanban)
Describe importance of flexibility
Differentiate product layout, process layout, fixed position layout, and cellular layout
Differentiate straight-line, U-shaped, S-shaped, convoluted and comb patterns
Describe advantages/disadvantages of layout and patterns
Explain importance of product protection, identification and storage
List methods of identifying products (e.g., labels, bar codes, radio frequency systems and magnetic strip systems)
Describe manual methods of storage and retrieval
Describe automated storage and retrieval systems (ASRS)
Describe automated guided vehicle moving systems (AGVS)

Competency: Apply JIT

Comptency Builders:

Maintain system for physical handling and movement of material in-process and in-storage
Monitor system of physical handling and movement of material in-process and in-storage
Maintain system for physical handling and movement of finished products
Monitor system of physical handling and movement of finished products
Write requests for deviation from specifications
Implement quality control and inspection standards and procedures
Write engineering change notices and rejection reports
Monitor reports of discrepancy or rejects during production process
Conduct quality tests under different environmental conditions

Competency: Demonstrate knowledge of inspection

Competency Builders:

Explain purpose of inspection
Describe scope of inspection
Explain purpose of incoming, ongoing, and final inspections
Explain early detection inspection
Explain how statistical process control (SPC) aids inspection
Define types of nonconformance
Define degrees of nonconformance
Define corrective action
Describe when to 100% inspect
Describe when to sample inspect
Describe methods of testing for material properties (e.g., harness, strength, chemical makeup, flaws, errors in tooling or setup)
Define rework, salvage, and scrap
Describe ethical decisions an inspector may make
Identify purposes of computer-automated inspection
Explain advantages and limitations of automated inspection
Explain disposition of non-conforming material
Explain basic foolproofing concept to build inspection into process (i.e., poka-yoke)
Use checksheets to organize and record inspection results

Competency: Inspect machinery, materials, and products

Competency Builders:

Identify critical material characteristics from specification(s) or drawing(s)
Perform capability studies for machinery and materials acceptance
Identify appropriate acceptance sampling plan
Conduct incoming materials inspection using sampling plan criteria
Identify critical in-process characteristics from specification(s) or drawing(s)
Demonstrate basic metrology skills
Conduct in-process inspection
Identify appropriate inspection reports and follow-up
Gauge R and R (reproducibility and repeatability)
Apply geometric tolerancing
Explain C = O (zero) acceptance plan
Interpret instructions in a control plan

Competency: **Demonstrate knowledge of nondestructive testing**

Competency Builders:

Describe purpose of nondestructive testing
Identify anomalies
Define defects and discontinuities
Identify factors contributing to defects and discontinuities
Describe ultrasonic testing
Describe advantages and limitations of ultrasonic testing
Describe industrial radiography
Compare use of wet and dry particles in magnetic particle inspection
Explain advantages and limitations of penetrant inspection
Describe microwave testing
Describe holographic inspection
Explain choice of most suitable nondestructive test method
Describe eddy-current testing

Unit: Technical Recording and Reporting

Competency: Demonstrate proficiency in technical recording

Competency Builders:

Describe various documentation procedures
Interpret specifications or drawings
Observe process
Ask open-ended questions
Record process (e.g., flowchart, step-by-step)
Identify parameters
Record accurate, truthful data
Maintain test logs
Compile cumulative reference notebook/record
Measure appropriate parameters
Draft preventive maintenance and calibration procedures

Competency: Demonstrate proficiency in technical reporting

Competency Builders:

Use data books and cross reference/technical manuals
Compose technical memoranda
Identify type of report or format needed
Use appropriate format
Compile relevant data
Design charts and graphs
Analyze data
Draw conclusions
Explain analytical methods used
Outline reports
Write reports
Present reports

Unit: Computer Literacy

Competency: Describe personal computer operations

Competency Builders:

Explain how data is stored in main computer memory
Explain how computer system executes program instruction
Explain computer storage capacity
Explain how data is represented
Describe data storage techniques
Identify types of memory

Competency: Explain information processing cycle

Competency Builders:

Define operating systems (e.g., DOS, OS/2, UNIX, MAC)
Describe computer languages and their use
Describe computer languages and their use
Describe computer languages and their use
Describe difference between data files and program files
Explain PC layout
Explain PC network layout
Explain mini/mainframe network layout
Differentiate hardware and software
Differentiate open from proprietary architecture

Competency: Operate computer hardware

Competency Builders:

Practice proper media handling techniques (e.g., magnetic fields, dust, liquids)
Identify hardware and its use
Use hardware (e.g., mouse, diskettes, drive, modems, touch screen, printers, digitizers, scanners, cables, protection devices)
Keyboard efficiently
Demonstrate basic care of hardware
Explain need for and application of security levels/procedures
Perform basic hardware troubleshooting
Explain hardware addressing techniques

Competency: Use software

Competency Builders:

Define software types and functions
Describe basic disk operations and care
Perform functions necessary to operate software
List advantages and disadvantages of integrated and dedicated software
Operate system software
Operate diagnostic software
Demonstrate basic proficiency in spreadsheet use
Demonstrate basic proficiency in word processing
Demonstrate basic proficiency in database use
Demonstrate basic proficiency in network use
Demonstrate basic proficiency of utility (e.g., WINDOWS, GUI)
Demonstrate basic proficiency in report writing
Demonstrate system commands
Differentiate ethical use/misuse of software
Describe bulletin boards/electronic mail
Apply security levels/procedures while handling sensitive data
Explain data compression techniques
Explain use and deletion of passwords

Unit: Workplace Safety

Competency: Apply general safety precautions

Competency Builders:

Identify local, state, and federal rules and regulations
Identify personal protective wear and equipment
Identify visual controls (e.g., monitors, read outs)
Identify auditory controls
Identify common sense housekeeping
Interpret hazardous materials notices on containers
Use personal protective wear and equipment
Apply workplace safety rules and procedures
Apply personal safety rules and procedures
Apply workplace organization (e.g., housekeeping)
Apply applicable electrical, mechanical, steam, hydraulic and (e.g., pneumatic safety rules and procedures)
Apply fire safety rules and procedures
Apply hazardous wastes rules and procedures
Apply first aid
Locate (MSDS)
Perform lockout and tagout
Recycle scrap metal, chips, shavings, coolants, solvents, trash, and waste materials
Apply common sense housekeeping
Use preventive maintenance checklists

Competency: **Demonstrate knowledge of safety and workplace hazards**

Competency Builders:

Describe corrective procedures for unsafe conditions
Identify types and potential level of workplace hazards (e.g., physical hazards, fire, chemicals, noise, ionizing radiation, ultraviolet, temperature extremes, ergonomics, biological hazards)
Identify safety materials/equipment (e.g., absorbant socks, oil dry)
Interpret Material Safety Data Sheets (MSDS)
Explain purpose(s) of OSHA and NIOSH
Explain purpose(s) of NEC and NFPA
Identify purpose of emergency evacuation routes, master switch and lockout locations, and safety color coding systems
Identify roles of industrial hygienists, safety professionals, occupational physicians, and occupational nurses
Describe methods of evaluating potential hazards (e.g., visual analysis)
Describe methods of correcting potential hazards
Describe various types of toxicity (e.g., chronic, immediate)
Identify need for reporting accidents
Explain precautions required when using toxic or flammable materials
Define confined space and related requirements
Explain how international directives relate to safety

Competency: **Explain purpose of industrial pollution control systems**

Competency Builders:

Describe types of air, water, solid waste, and noise pollution
Explain purpose of air pollution control systems
Explain purpose of water pollution control systems
Explain purpose of solid waste pollution control systems
Explain purpose of noise pollution control systems
Explain basic philosophy of "right to know" legislation
Explain purpose(s) of EPA
Identify "costs" of industrial pollution control (i.e., dollars vs. impact to environment)
Describe ethics of environmental issues

Competency: Demonstrate knowledge of ergonomics

Competency Builders:

Define ergonomics
Define risk factor
Define maximum permissible limit (MPL) and action limit (AL) for lifting
Define cumulative trauma disorder (CTD)
Identify susceptibility factors for CTD
Minimize extreme joint movement
Minimize use of excessive muscle force
Minimize repetitive tasks
Minimize mechanical stresses (e.g., sharp edges, heat, cold, hard surfaces, weights, vibration)
Minimize awkward body positions
Explain use of rest pauses
Explain need for mats and footrest for standing jobs
Explain need for appropriate working heights of chairs, stools, workbenches, equipment
Explain need for adequate lighting
Explain use of anthropometric (i.e., centering one's view of everything around man) design

Unit: Supervision

Competency: Perform supervisory functions

Competency Builders:

Define supervision
Conduct task analysis
Create organizational and/or departmental charts
Apply company policies and procedures
Maintain workplace procedures manuals
Prepare budgets
Monitor budgets
Prepare managerial reports
Analyze daily production reports
Maintain appropriate work environment
Conduct tours
Facilitate assignments
Assign work
Delegate job tasks
Monitor progress
Prepare productivity reports
Provide training for new policies
Troubleshoot workplace problems
Coordinate workplace activities
Appraise performance
Document personnel issues
Coordinate administrative duties

Competency: Coordinate training

Competency Builders:

Assess training needs
Secure training resources, materials and equipment
Train employees
Evaluate progress of trainee
Provide feedback
Solicit feedback
Receive feedback
Assess feedback

Unit: Microcomputer Electronics Technology

Competency: **Demonstrate basic proficiency in microprocessor systems**

Competency Builders:

Describe essential components of microprocessor and their functions
Describe principles and operation of BUS concepts (e.g., VESA, EISA)
Describe principles and operation of types of memory circuits
Identify operating systems (e.g., DOS, OS/2, UNIX)
Describe microprocessor instructions sets
Describe principles and operation of microprocessor machine code
Demonstrate use of microprocessor machine code
Decode microprocessor machine code
Identify types of input and output devices and peripherals
Describe principles and operation of storage devices
Operate oscilloscopes and logic/data analyzers
Interface input and output ports to peripherals
Demonstrate ability to interface peripherals
Identify central processing unit building blocks and their uses
Identify the levels of computer languages

Competency: Demonstrate basic proficiency in computer systems architecture

Competency Builders:

Describe the principles and operation of computer system architecture
Operate computer system architecture
Repair computer system architecture
Describe the principles and operation of addresses and interrupts
Describe the principles and operation of volatile and non-volatile memory
Demonstrate the use of volatile and non-volatile memory
Repair or replace volatile and non-volatile memory
Describe the principles and operation of advanced memory techniques
Define individual system blocks
Draw systems configuration in block detail
Interpret computer acronyms
Describe priorities and interrupts at systems level
Identify direct memory access data handling system(s)
Define functions of advanced memory techniques (e.g., virtual, pipeline, cache)
Troubleshoot a microcomputer system

Competency: Demonstrate proficiency in software fundamentals

Competency Builders:

Load operating system software
Run operating system software
Load diagnostic software
Run diagnostic software
Construct flow charts
Analyze flow charts
Explain computer languages and their uses
Write a simple computer program
Write program documentation
Describe firmware applications
Identify the need for backup
Describe security measures
Describe virus protection

Competency: Describe elements of communication interfacing

Competency Builders:

Define common EIA, IEEE, and CCITT communication standards (e.g., EIA 232 and 485; IEEE 488)
Identify sync devices
Identify async devices
Identify types of network (e.g., token ring, ethernet)
Identify networking levels or layers
Identify protocols
Identify packet switching
Identify multiuser systems
Operate network analyze devices
Identify network analyzer devices (e.g., breakout bos, sniffers)

Competency: Describe peripheral equipment interfaces

Competency Builders:

Identify types of card and paper-tape equipment and interface controllers
Define printer types and interface controllers
Explain the operation of typical magnetic tape equipment and interface controllers
Identify disk equipment and interface controllers
Define environmental requirements for peripherals and media

Unit: Drafting Technology

Competency: **Apply basic drafting skills**

Competency Builders:

Use drafting equipment, measuring scales, drawing media, drafting instruments and consumable materials, blueprint machine
Identify line styles, weights (alphabet of lines)
Select proper drawing scale, introduction to different types
Prepare title blocks and other drafting formats
Apply freehand and other lettering techniques
Prepare multi-view drawings
Prepare multi-view sketches
Prepare orthographic views
Prepare change control block
Describe change control block/revision block
Measure angles
Draw horizontal, vertical, angular, parallel, and perpendicular lines
Transfer an angle
Construct tangent lines (to arcs) and tangent arcs (to arcs)
Bisect angles and arcs
Bisect lines
Divide lines
Construct three-point circle
Construct regular hexagon, pentagon, and octagon
Reproduce a drawing
Prepare single-view drawings
Prepare dimension drawings
Interpret notes and dimensions to determine part
Draw arcs, circles, and conics
Transfer measurements

Competency: Apply intermediate drafting skills

Competency Builders:

Describe types of blueprints and their applications
Apply isometric, oblique and perspective sketching techniques
Prepare isometric, oblique and perspective sketches
Prepare sectional views
Prepare auxiliary views
Identify ANSI symbols
Prepare views of drilled and tapped holes, counterbores, countersinks
Apply systems drafting techniques
Identify a bill of materials
Dimension drawings using ANSIy14.5 standards
Describe purpose of auxiliary and sectional views

Competency: Apply advanced drafting skills

Competency Builders:

Interpret reports and specifications
Prepare pictorial drawings
Prepare schematics
Draw conics
Interpret basic pneumatic/hydraulic standard and symbols
Interpret various drawings (e.g., welding, casting, stamping, forging, civil, maps, pattern shop)

Competency: Interpret basic prints

Competency Builders:

Visualize object from drawing
Interpret orthographic projections
Interpret isometric views
Interpret sectional views
Interpret detail and assembly drawings
Interpret dimensions
Interpret tolerances

Competency: Interpret intermediate prints

Competency Builders:

Interpret screw thread specifications
Identify structural steel shapes
Interpret special symbols
Interpret electrical, pneumatic/hydraulic drawings
Interpret schematics

Competency: Interpret advanced prints

Competency Builders:

Interpret GD&T characteristic symbols
Interpret GD&T supplementary symbols

Competency: **Demonstrate knowledge of basic geometric dimensioning and tolerancing**

Competency Builders:

Identify geometric characteristics and symbols (i.e., flatness, straightness, roundness, cylindricity, profile of line, profile of surface, perpendicularly, angularity, parallelism, circular, runout, total indicated runout, position, concentricity, and symmetry)
Define maximum material condition
Define least material condition
Define regardless of feature size condition
Describe feature control blocks
Describe datum surfaces and targets
Define flatness (pitch)
Define straightness (yaw)
Define roundness
Define cylindrically
Define profile of line
Define profile of surface
Define perpendicularity
Define angularity
Define parallelism
Define circular runout
Define total runout
Define true position concept to determine tolerance for location of holes in mating parts

Competency: **Convert dimensions and tolerances**

Competency Builders:

Convert dimensions and tolerances from English units to metric units
Convert dimensions and tolerances from metric units to English units

Competency: Apply revision control process

Competency Builders:

Apply drawing balloons
Apply documentation (including project filing, back-up material, tracking process)
Apply change control block
Apply revision levels

Competency: Demonstrate dimensioning techniques

Competency Builders:

Construct arrowheads using various styles/disciplines
Apply symbols for surface and texture control
Add labels/notes to drawing
Interpret decimal tolerance dimensions
Dimension arcs
Dimension angles
Dimension curves
Dimension rounded-end shapes
Dimension spherical objects
Dimension cylindrical objects
Dimension cones, pyramids, and prisms
Dimension features on circular center line
Dimension theoretical point of intersection
Dimension object using rectangular coordinate system
Dimension object using polar coordinate system
Dimension object using tabular coordinate system
Dimension object using ordinate dimensioning system

Competency: Apply geometric dimensioning and tolerancing

Competency Builders:

Interpret decimal tolerance dimensions
Calculate clearance fit tolerances of mating parts
Dimension clearance fit tolerances of mating parts
Calculate interference fit tolerances of mating parts
Dimension interference fit tolerances of mating parts
Calculate tolerances to mating parts using standard fit tables
Assign tolerances to mating parts using standard fit tables
Apply positional and form tolerancing symbols
Apply symbols for true position
Apply symbols for maximum material control and regardless of feature size
Calculate effects of dimensional stack-up
Calculate transitional fit tolerances
Dimension transitional fit tolerances

Competency: Perform basic physical layouts

Competency Builders:

Use inside diameter (ID), outside diameter (OD), and hermaphrodite calipers
Layout with combination square
Layout with scriber, divider and trammel
Use surface plate
Use surface gage
Use layout fluid
Use V-blocks
Use clamps
Use angle plate
Use parallels
Use punches
Use transfer method tools
Use layout hammer
Use machinist's square
Use universal bevel protractor
Use machinist's scale

Competency: Prepare mechanical drawings

Competency Builders:

Interpret basic mechanical standards and symbols
Prepare assembly drawings
Prepare welding drawings
Prepare bearing drawings
Prepare casting drawings
Prepare forging drawings
Prepare tool drawings
Prepare molding diagrams
Prepare drawings with special processed holes
Prepare stamping drawings
Prepare numerical control drawings/instructions
Prepare installation drawings
Prepare purchase part drawings
Prepare approval drawings

Competency: Prepare advanced mechanical drawings

Competency Builders:

Resolve problems by descriptive geometry and revolutions
Use precision dimensioning to include geometric characters
Use precision measuring instruments (e.g., calipers)
Prepare fastener drawings
Prepare cam drawings
Prepare gear drawings
Prepare spring drawings
Prepare pulley and chain drive drawings

Unit: CADD Fundamentals

Competency: **Demonstrate basic use of computer operating system**

Competency Builders:

Create ASCII text files with a text editor
Explain rules for naming files and directories
Manage files
Create directories
Remove directories
Change directories
Copy files
Rename files
Erase files
Format diskettes
Label diskettes
Explain the syntax of operating system commands
Use wildcards in operating system commands

Competency: **Operate a CADD system**

Competency Builders:

Execute CADD system
Use keyboard input
Use screen and tablet menus
Use other input devices (e.g., scanner, digitizer)
Create scaled plots
Operate a pen plotter
Operate a printer-plotter (i.e., laser plotter)
Access on-line help for commands
Use file conversion
Use data transfer

Competency: Select entities for action

Competency Builders:

Add or remove entities separately
Add or remove entities using a window
Add or remove entities with a crossing-box
Select entities using a fence
Select entities by other methods (e.g., last, previous, type, all, etc.)

Competency: Create 2-D orthographic drawings

Competency Builders:

Create primitive drawing entities
Draw utilizing absolute Cartesian coordinates
Draw utilizing relative Cartesian coordinates
Draw utilizing polar coordinates
Draw using construction aides (e.g., snaps, grid, snap, etc.)
Change drawing attributes
Edit drawing entity properties (e.g., color, layer, thickness, linetype)
Construct drawing entities (e.g., offset, timer, extend, break, mirror, etc.)
Edit drawing entities (e.g., offset, trim, extend, break, mirror, etc.)
Set system variables (e.g., units, scale)
Use system variables
Create layers
Name layers
Manipulate layers
Save files
Create back-ups
Create hatches, patterns, symbols
Recall drawing templates/blocks

Competency: Annotate orthographic drawings

Competency Builders:

Create text styles
Edit text styles
Select text styles
Apply notes

Competency: Dimension orthographic drawings

Competency Builders:

Create dimensions
Edit text
Control dimension variables/models

Competency: Control display

Competency Builders:

Apply view control while drawing (e.g., zoom and pan)
Control view resolution (e.g., viewers)
Save views
Display views

Competency: Extract entity and drawing information

Competency Builders:

Measure distances
Measure areas
Identify locations
List entity characteristics (e.g., length, size, location, properties, etc.)

Unit: Application Programming and Design

Competency: Demonstrate knowledge of computer applications

Competency Builders:

Describe hardware component functions
Differentiate data elements (i.e., fields, records, files)
Define file (keyed and non keyed) database types
Describe uses of a computer
Describe major events in the development of computers
Describe major types of software and their functions
Read computer publications
Interpret computer trends
Describe batch processing
Describe interactive processing
Describe ad hoc reporting

Competency: Create computer applications

Competency Builders:

Use appropriate reference materials
Analyze specifications
Devise design specifications into logical blocks
Identify constraints
Identify programming language
Identify input and output (I/O) requirements
Prepare logic using program-flow diagram

Competency: Demonstrate knowledge of programming theory

Competency Builders:

Explain the meaning of "reserved word"
Describe arrays and tables
Explain compilers
Differentiate system documentation from user documentation
Describe what is meant by top-down design and structured programming
Identify the steps in the program development cycle
Design a decision table for a specified problem
Identify the steps ad procedures required to develop tests data
Explain the difference between recursion and iteration
Describe what is meant by data validation

Competency: Apply programming theory

Competency Builders:

Demonstrate use of working storage variables
Write source code per standards
Use spacing charts to plan program output
Code a modular program
Interpret a simple hierarchy chart
Interpret a simple pseudocode design
Create a flow-chart
Perform program sorts
Demonstrate use of loops
Demonstrate use of logical operators (e.g., AND, OR, NOT)
Demonstrate use of arrays and tables

Competency: Demonstrate proficiency in a programming language

Competency Builders:

Identify primary use of programming languages and their weaknesses
List rules for naming variables for different programming languages
Declare variables
Initialize variables
Modify variables
Perform character manipulation
Demonstrate a function
Demonstrate a subroutine
Demonstrate system calls
Apply conditional statements
Evaluate series of logical expressions
Code separate addition, subtraction, multiplication, and division statements
Declare a one-dimensional array
Initialize an array
Generate executable code

Competency: Use operating system

Competency Builders:

Apply appropriate text editor (e.g., create, save, restore, copy and edit source files)
Apply operating system commands
Apply operating system utilities

Competency: Test programs

Competency Builders:

Describe various types of test programs
Explain debugging statements
Perform debugging functions
Debug compilation errors
Create test data that checks logic and error routines
Execute program with test data
Correct execution errors
Perform unit integration test
Analyze test results

Competency: Apply programming skills

Competency Builders:

Demonstrate knowledge of file and table processing
Write program using data validation techniques
Write interactive process
Write menu-driven program
Write database program
Write program that utilizes a recursive process
Write program using copy libraries
Write program using system calls
Write program using design tool

Competency: Demonstrate proficiency in documentation

Competency Builders:

Write program documentation
Write user documentation
Construct data-flow diagrams
Update design documentation

Competency: Apply systems design process

Competency Builders:

Identify processing requirements
Use appropriate reference materials
Describe role of user and management in the development of a computer system
Describe use of data flow diagrams, system flowcharts and display screen layout forms
Conduct interviews to define programming specifications
Design system inputs and outputs and processes
Create design documentation
Present system design

Competency: Evaluate system

Competency Builders:

Identify evaluation criteria
Write test plan
Analyze test data
Present results

Competency: Implement system

Competency Builders:

Write implementation plan
Identify conversion method
Train personnel
Present implementation plan
Implement plan
Revise/adapt plan
Complete the plan
Document action taken

Unit: Local Area Network (LAN) Operations

Competency: Explain LAN operations

Competency Builders:

Define local area network
Define different types of LANs
Differentiate network operating systems from data distribution systems
Identify advantages and disadvantages of various LAN operating systems
List duties of LAN supervisor
Define security levels

Competency: Apply LAN operations

Competency Builders:

Assess user needs to determine which LAN operating systems to use
Configure system
Change hardware as needed
Install application software
Demonstrate applications used on LANs
Operate the system in a multi-user environment
Describe various networks and their compatibility
Differentiate among various topologies

Competency: Maintain LAN

Competency Builders:

Use appropriate reference materials
Respond to system messages
Troubleshoot system
Run diagnostic software
Back up system(s)
Restore system(s)
Perform system analysis
Use security procedures
Perform preventive maintenance
Explain how LAN software is installed
Explain how network protocols work together